FLIGHT

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June 1 ..	**Ashwell-Cooke Challenge Cup, Lympne.**
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June 8-15 ..	**F.A.I. Conference, Paris.**
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June 9 ..	**Northampton Flying Meeting.**
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June 21 ..	**Air Rallye at Haldon Aerodrome, Teignmouth.**
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Sept. 27 ..	**N.F.S. Air Meeting, Hanworth.**
Nov. 28-Dec. 14	**Paris Aero Show.**

EDITORIAL COMMENT

PROBABLY, the whole world breathed a sigh of relief when the news came through that Miss Amy Johnson had safely reached Australia. Frankly, it had been disquieting to read of the fatigue to which she had confessed after her quite terrifying experiences in crossing the Dutch East Indies. There is also such a thing as fatigue of metal, and her Gipsy engine had been worked very hard since she left England. The Moth, too, had had to put up with some rough usage. None of the three factors necessary to success can have been in quite that fine fettle which is desirable before a landplane with a single engine takes off to fly for four or five hundred miles across the open sea. But all went well. The Moth and the Gipsy lived up to their reputations, and the plucky pilot did not fail. Fortune, in this case, favoured the brave, though the fickle goddess has not always, alas! been so kind to those who take great risks in the air. We do not approve of such risks in a landplane over the sea; but as all has ended happily, we gladly join in the pæan of praise which the whole world is singing to Miss Amy Johnson. She is undoubtedly a very fine pilot and navigator, as well as being the only British woman to hold a ground engineer's certificate. It is her ability even more than her courage which awakes our admiration, for, while adventurous pilots are many, those who have the skill to win through are still a minority.

Amy Johnson's Success

We are proud that Miss Johnson is of British birth and blood, but there is a significance in the fact that her grandfather came to England from Denmark. This puts her into the same class as Erik Nelson, the American Swede, who was one of the two first men to fly round the world; as Lindbergh, the American Swede, who was the first man to fly solo across the Atlantic; as Ben Eielson, another American of Norse extraction, who was the first man to fly across the Arctic Ocean; as Bernt Balchen, who was Byrd's second pilot on his Atlantic flight, and as Amundsen himself. That Viking spirit will out.

The Graf Zeppelin

The German airship "Graf Zeppelin," it seems impossible to avoid saying, has done it again. She has only failed once, and that was the fault of the engine department, not of the airship. Her progress across the south Atlantic from Spain to Brazil, has been as uneventful as we could wish that all air journeys should be. She met head winds, not only when crossing the ocean, but also when flying south from Pernambuco to Rio de Janeiro, and so her progress was not as fast as it might have been. But, so many people have never crossed the south Atlantic so fast before, and so the flight has made history. Had this airship a better streamline shape, she would probably have progressed faster than she did against the unfavourable winds. Her shape was not selected as the result of wind tunnel tests, but was imposed upon her designers by the height of the only construction shed which was available. The next German airship, we are assured, will have a fineness ratio resembling that of the two British rigids.

This is the first time that an airship has crossed the Equator; it is the first time that an airship has visited the native land of Santos Dumont; and it is, we believe, only the second time that an airship has flown into the Tropics. The only previous Tropics flight on record is that of the Zeppelin L 59, which started from Jamboli in Bulgaria for Tanganyika on Nov. 16, 1917, and covered 2,000 odd miles of Africa before she was recalled by wireless. There is an undoubted risk in taking an airship which is inflated with hydrogen and whose engines are driven by petrol or any other inflammable fuel into the intense heat of the Tropics. The "Graf Zeppelin" has suffered nothing from the experience except a somewhat rapid evaporation of water. It is a principle, however, when estimating a performance in the air, not to accept one success as proof, or one failure as disproof, of the legitimacy of the feat. The record of the Zeppelins in the war impresses us with the general safety and reliability of hydrogen-petrol airships in temperate climates. The two successful flights through the Tropics do not prove that it is desirable to take such airships into intense heat. It is our belief that the use of heavy-oil fuel makes the difference between safety and danger, and for that reason it is R 101 and not R 100 which has been selected for the flight to India. Dr. Eckener, when he was in England some time ago, expressed his belief in helium gas for inflation, and believed that he could get it in sufficient quantities. He did not say at what price. Even if that gas could be obtained at a commercial rate, it is no light matter to sacrifice some 5 per cent. of an airship's lift. For the present, at any rate, the best road to safety seems to lie in the development of the Diesel engine.

One very interesting feature of the voyage of the "Graf Zeppelin" is the use of portable and presumably cheap stump mooring masts. One of these was sent to Seville and erected there, and another to Pernambuco. At these masts the airship was able to refuel, and, we presume, to refill her gas bags. At Rio, as at Cardington, the "Graf Zeppelin" was held down by a landing party. The good people of Rio were very disappointed that she only stayed aground for some two hours; but an airship captain cannot be anxious to spend too long at a human mooring mast. The use of these stump masts opens up new possibilities for the use of airships. The ships are not tied, as was generally thought, to the five or six airports in the world where full-sized towers have been erected. The stump mast, we imagine, would not be a safe mooring in a heavy gale, such as the one which R 101 rode out at Cardington, but in places where the weather is generally favourable it can make occasional visits possible. They may well prove useful in the future for intermediate ports of call on regular airship routes. Doubtless the present form of the mast is experimental. It may well come about that the mooring tractor, of the kind which is to be developed at the Royal Airship Works to move an airship from the tower to the shed, will prove the best form of temporary mooring for an intermediate port of call. But, working with the means at the disposal of the Zeppelin Company, Dr. Eckener and his collaborators have carried out an interesting and useful experimental flight. In some respects they have had good luck, but they none the less deserve congratulations on their achievement.

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London's Air Port

A deputation from the Air Ministry consisting of Mr. Montague, Under Secretary for Air, Sir Sefton Brancker, and Maj. R. Mealing, has been in consultation with the Parks and Open Spaces Committee of the L.C.C. to consider the question of a central airport for London. This is not intended to supersede Croydon, but to supplement it. Three open spaces are to receive serious consideration, namely, Hyde Park, Regent's Park, and Battersea Park.

It is admitted on all sides that the 40 min. which it takes to get from Charing Cross to Croydon considerably detracts from the utility of air services over short distances, such as a trip to Paris, though the additional time is of no importance to a passenger bound for India or South Africa. The traffic on the short services has been growing steadily, but these services must always be of very small moment compared with the far-flung Empire routes. The great parks of London are of such immense importance, not only to the health of the population, but to the happiness of their lives, that the idea of converting one of them to a utilitarian purpose will probably fill every lover of London with horror. An aerodrome is not æsthetically offensive as a railway station is, and it does not pollute the atmosphere with smoke. But can anyone picture a hangar on the site of the Arsenal, the Serpentine filled in and converted into a tarmac run-way, a stop put to Mr. Lansbury's mixed bathing scheme, and the abolition of the ducks and Peter Pan? It is true that the removal of Rima might almost reconcile us to the idea, but on the whole deal the citizens' gain would not outbalance their loss. Or, take Regent's Park. Must the roaring of the African lions and the Brazilian jaguars give way to the music of their Napier and Armstrong-Siddeley namesakes? The gods forbid! Seriously, we believe that nothing would, at the moment, however opinion may swing round later on, bring air transport into such general disfavour as an interference with the London parks. Some other solution of the problem will, we trust, be found. Have all the possibilities of an amphibian feeder service between Croydon and the Thames been explored and rejected?

AMY JOHNSON'S TRIUMPH

ENGLAND— AUSTRALIA

MISS AMY JOHNSON.
(FLIGHT *Photo*.)
10229

MISS AMY JOHNSON, flying her Gipsy Moth, arrived safely at Darwin in Australia on Empire Day, May 24, thereby completing the first solo flight by a woman in a light aeroplane from England to Australia. Her pluck and her unexpected skill have captured the public imagination to an unprecedented degree. In herself she is a modest but very earnest young woman of 22, a native of Hull, where her father is prominently identified with the fishing industry. Her paternal grandfather, Anders Jorgensen, was a Dane, born at Assens, Fyen Island. When he was 16 years old he came to Hull in a sailing ship and settled there and his name naturally became Johnson. His sister is still alive, and lives in Copenhagen. Anders Johnson married a Yorkshire woman named Mary Ann Holmes. Mr. Johnson senior is now a widower and lives at Bridlington. He had several sons, one of them being the father of our present heroine. On hearing of his daughter's safe arrival, her father sent a wireless message to the fishing fleets in the North Sea, telling them that Amy has the blood of the trawling industry in her veins.

Miss Amy Johnson is a B.A. of Sheffield University and took up flying, at Stag Lane Aerodrome, two years ago. She made her first solo on June 9 last year and subsequently gained an Air Ministry ground engineer's licence, being the first woman to do so.

The story of Miss Johnson's flight is briefly recorded in the following daily log.

May 5. Croydon-Vienna (800 miles).—Miss Johnson was on Croydon Aerodrome at dawn, ready to get away. A minor adjustment to an oil pipe, however, caused slight delay, and she did not start until 7.45 a.m. At 5.50 p.m. she landed at the Asperne Aerodrome, Vienna, having accomplished the journey non-stop, with good weather and without incident.

May 6. Vienna-Constantinople (800 miles).—Starting off early from the Asperne Aerodrome, Miss Johnson made another fine non-stop flight to Constantinople, where she landed on the San Stefano Aerodrome in the evening, being received by the Turkish commander. She reported that weather conditions were fine except for bad rainstorms over the Balkan mountains. Although she had been 12 hours in the air Miss Johnson at once put in three hours or so overhauling her Gipsy-Moth.

May 7. Constantinople-Aleppo (550 miles).—Although ready to start at dawn, another short delay was caused by a minor adjustment. However, she got away at 10.30 and managed to reach Aleppo in the evening. *En route* she experienced some trouble in crossing the Taurus Mountains, at about 8,000 ft., with the heavily-laden machine. Visibility was bad, and flying through dense clouds she followed the railway line through the narrow pass and eventually succeeded in overcoming the obstacle.

May 8. Aleppo-Baghdad (470 miles).—An exciting day! Mid-way between Aleppo and Baghdad Miss Johnson encountered a violent gale, which brought her down from 7,000 ft. to about 300 ft. in the space of 10 minutes. Dense clouds of sand at this altitude rendered visibility practically nil, so she decided to land in the desert. This she accomplished safely, and blocking the wheels of the machine with luggage, tool boxes, etc., and covering up the "Gipsy" as best she could, she waited for conditions to calm down a bit. After a most uncomfortable two hours—expecting Arabs to swoop down at any moment!—the storm abated somewhat, so she started off once more. Visibility was still bad, but flying eastwards she managed to pick up the Tigris, which she followed until the junction with the Diala gave her her position—which was some 10 miles south of Baghdad. It was then an easy matter to make her destination, and shortly after she made an excellent landing at the Imperial Airways Aerodrome at Baghdad. The staff, more or less taken by surprise by her arrival, turned out in force, and after giving her an enthusiastic welcome, turned their attention to the "Jason Wanderer" whilst its owner obtained some much-needed refreshment and rest.

May 9. Baghdad-Bander Abbas (830 miles).—The journey from Baghdad to Bander Abbas was uneventful except for the terrific heat along the Persian Gulf, and that on landing at Bander Miss Johnson had the misfortune to break a front strut bolt. The latter damage, however, was soon repaired, and the machine was got ready for an early start for Karachi next morning.

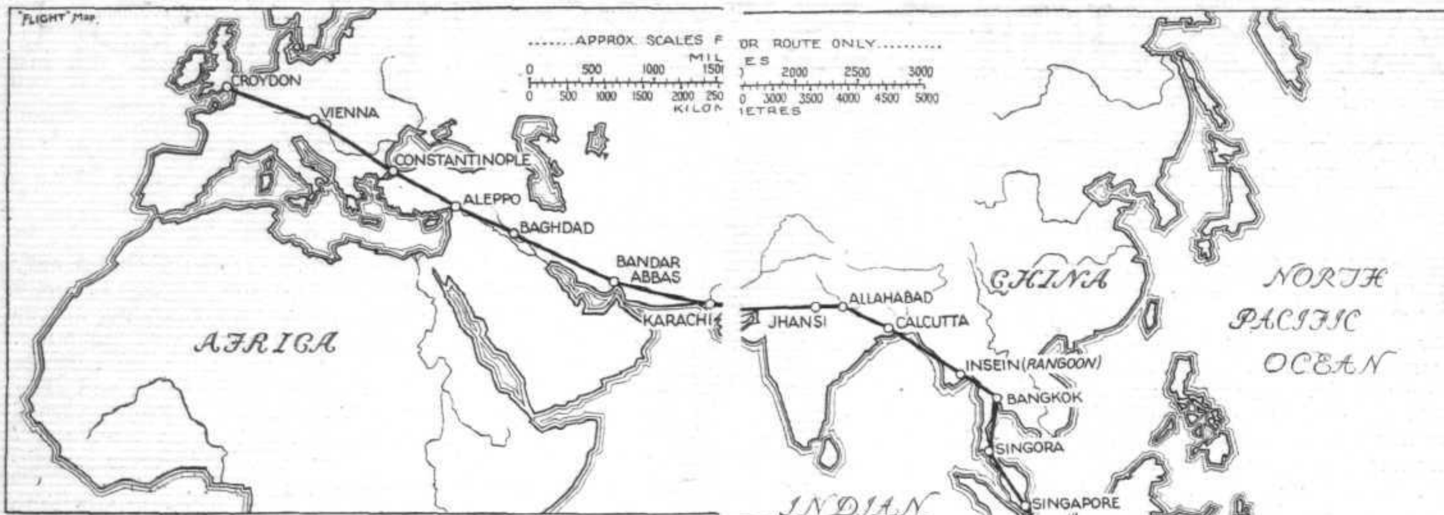
May 10. Bander Abbas-Karachi (730 miles).—Starting at daybreak Miss Johnson made another long hop to Karachi, when she received an enthusiastic welcome on landing. By reaching Karachi in six days, she set up a new record for a solo flight from England to India, beating Bert Hinkler's time for the journey by two days.

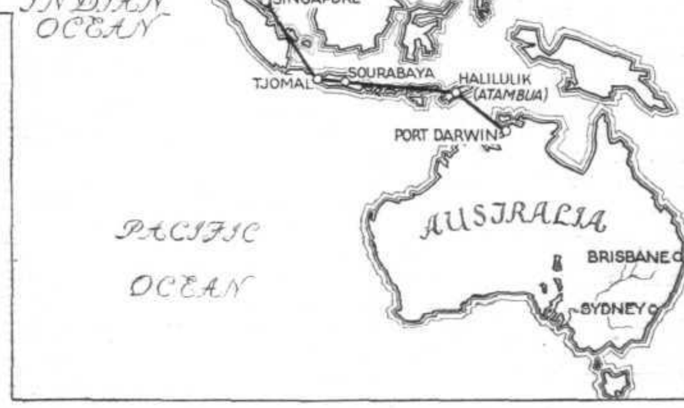
May 10. Karachi-Jhansi (740 miles).—Before leaving Karachi with the intention of flying to Allahabad, Miss Johnson was garlanded and handed a bouquet by the chief officer of the Karachi Municipality. She set out eventually accompanied for a part of her way by an escort of a Royal Air Force machine and another D.H. "Moth" piloted by Wing-Com. Crosby, the local De Havilland agent. The journey before her was considered to be one of the most dangerous stages of her flight. She made a plucky effort to reach Alahabad, but lack of fuel forced her down at Jhansi, a little over 200 miles short, on the Parade Ground, and in landing the machine crashed into a post and damaged a wing. This was repaired on the spot and she was able to proceed early next morning.

May 12. Jhansi-Allahabad-Calcutta (690 miles).—Miss Johnson arrived at Allahabad from Jhansi early in the morning, and after refuelling left without delay for Calcutta. She arrived at Dumdum Aerodrome, Calcutta, in the evening after encountering strong head winds on the way.

May 13. Calcutta-Insein, Rangoon (650 miles).—An unlucky day! In spite of bad weather reports she left Calcutta for Rangoon at 7 a.m. Up to Akyab conditions were pleasant, but after this she ran into strong head winds and rainstorms. The Yomas Range was crossed at about 1,200 ft., but visibility became so bad she had to descend to about 200 ft., and following the coast, tried to locate Rangoon. This she was unable to do, and after flying about for some time she decided to land in a suitable-looking field she had spotted. This proved to be Insein playing fields, some 10 miles from Rangoon, where she made a perfect landing, but while taxying the machine ran into a ditch, and the wings, landing chassis and propeller were smashed. Fortunately the damage was not very serious, but repairs occupied two days, so that Miss Johnson's chance of beating Bert Hinkler's time for the flight to Australia was now out of the question.

May 16. Rangoon-Bangkok (370 miles).—The "Jason Wanderer," having been taken to Rangoon Aerodrome, repaired and fitted with the spare propeller, Miss Johnson continued her flight on the 16th after a short test. She took off in heavy rain, and experienced an extremely boisterous journey to Bangkok. She had great difficulty in finding a passage through the mountains from Burma into Siam. After several attempts she succeeded in finding a way through, but she was unable to pick up any landmarks





Sketch Map of Miss Johnson's route to Port Darwin.

for several hours. Eventually she located the railway junction near Ayutha, and was able to make Bangkok—but almost dead beat.

May 17. Bangkok-Singora. (400 miles.)—Undaunted by her previous day's experiences, our "Johnnie" continued her plucky fight with fate and the elements, and left Bangkok early in the morning, with the intention of flying non-stop to Singapore, nearly 900 miles. Strong head winds over the Gulf of Siam, coupled with the fact that the new propeller was not giving the best of results, prevented this, however, and she had to land at Singora, on the east coast of the Malay Peninsula, with only about half the distance accomplished.

May 18. Singora-Singapore. (470 miles.)—Miss Johnson completed the next stage to Singapore without incident, being met just before reaching the aerodrome by two "Moths" from the Singapore Club, which escorted her into the 'drome. Having landed she at once proceeded to the R.A.F. officers' mess, where she had a meal and a rest. Meanwhile, the Singapore Club fitted a new starboard lower plane to her machine.

May 19. Singapore-Tjomal. (800 miles.)—Once again Miss Johnson's original plans could not be fulfilled; leaving Singapore at 6.10 a.m., she intended to fly to Sourabaya (about 1,000 miles), but the propeller handicap—she dared not fly at full speed for long with the unsuitable prop. for fear of overheating the engine—and so, when over Tegal, Central Java, she found she was running short of fuel. She looked for the emergency landing ground established near here, but could not find it; however, she picked out a small field which had been cleared for a house on the Tjomal sugar estate, near Pekilongan, and succeeded in making a perfect, but difficult landing. She was received by the manager of the estate, who, with his employees, helped in refuelling and preparing the machine for the next day's flight. Miss Johnson, having telephoned to Samarang (which was under an hour's flight away) spent the night on the estate as guest of the manager. When she landed some bamboo poles tore holes in the lower planes, but these were temporarily replaced with adhesive tape!

May 20. Tjomal-Samarang-Sourabaya. (200 miles.)—Leaving Tjomal at 8.45 a.m., Miss Johnson flew on to Samarang, proceeding shortly after, accompanied by a Dutch-Indiés mail 'plane, to Sourabaya, where she received a very hearty greeting from crowds of people on the aerodrome. A day was spent at Sourabaya repairing the damaged planes and making certain adjustments to the magneto—the hard working of the engine during the past few days having had their effects on certain parts, otherwise the engine, as a whole, was standing up to the strain magnificently.

May 22-3. Sourabaya-Atambua (Halilulik). (900 miles.)—All being satisfactory with machine and engine the flight was resumed at 6.5 a.m., the objective being Atambua. However, after having been seen passing over Bima during the morning, nothing more was heard of Miss Johnson until she was long overdue at Atambua—and naturally some uneasiness was felt for her safety. It was not until the next morning that news came through that she had landed at the village of Halilulik, about 12 miles from Atambua, where there was no telephonic communication. Her landing here was quite romantic, for as the machine came to rest, numbers of savage-looking natives, with swords and spears, rushed up, alarming her considerably at first. They proved to be quite friendly, however, and one took her hand and led her to the local church, where the priest received her and where she stayed the night. News of her safe landing was received at Atambua just in time to stop the departure of two Dornier Wal seaplanes which were being sent out to search for her. On May 23 she flew on to Atambua and prepared for the final stage, 500 miles across the Timor Sea, to Australia.

May 24. Atambua-Port Darwin. (500 miles.)—On Empire Day Miss Amy Johnson brought her remarkable and historic flight to a successful conclusion, having flown 9,900 miles from England to Australia in 19½ days. When she left Atambua weather conditions were perfect and she made good progress across the water. Midway she passed over the Shell Co.'s oil tanker *Phorus*, which wirelessed the news to Port Darwin. Forthwith several machines set out from Fanny Bay Aerodrome to meet her; they failed to locate her, however, and at about 3.30 p.m. she appeared off Port Darwin alone. Shortly after she made a graceful landing on the 'drome, amid enthusiastic cheers from the large crowd gathered there to welcome her. After a formal welcome by the Government Resident on behalf of the Commonwealth of Australia she was driven to Government House, where she was given a civic reception, and stayed as guest of the Government before proceeding south. Here, with the help of a secretary, she attended to the many messages of congratulation that came in.

CONGRATULATIONS

Congratulations on the successful conclusion of her flight to Australia have reached Miss Amy Johnson from all quarters. Here are some of the messages and views expressed:—

H.M. The King: The Queen and I are thankful and delighted to know of Miss Johnson's safe arrival in Australia and heartily congratulate her upon her wonderful and courageous achievement.

Mr. Ramsay MacDonald: My heartiest congratulations on your wonderful achievement. We have followed your flight with the keenest interest and admiration. We are very proud of you.

Lord Thomson, Secretary of State for Air: On behalf of the Air Council I send warmest congratulations on the completion of your magnificent flight. As the first woman pilot to fly to Australia you have achieved an outstanding feat of skill and endurance, and we have watched with admiration the coolness and courage which have carried you through to your goal in the face of unforeseen difficulties.

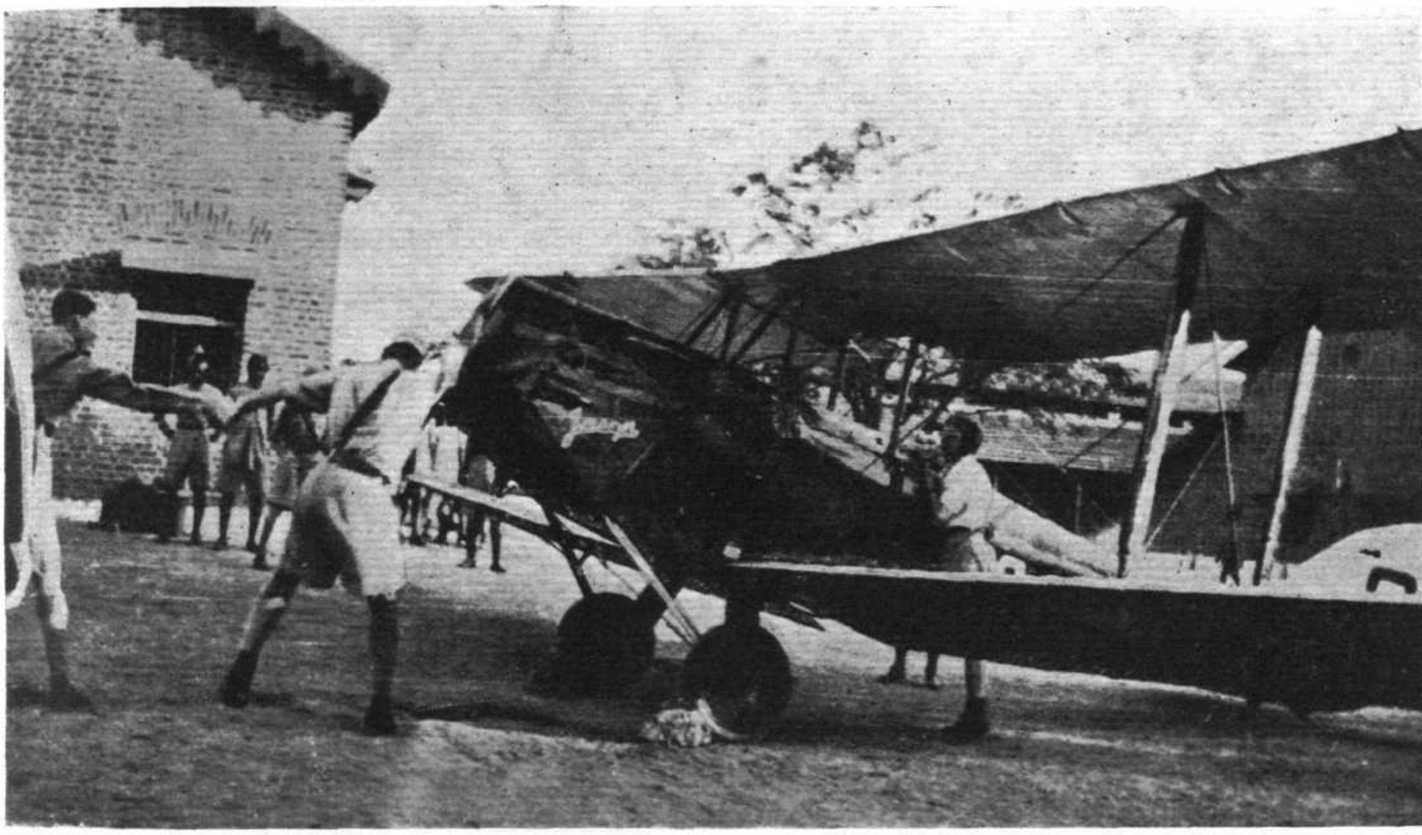
"AMONGST THOSE PRESENT"

CONTRIBUTING towards the success of Miss Amy Johnson's flight to Australia are numerous "incidentals." We cannot, for various reasons, go very fully into this matter, but we give below some of the principal and necessary helpers.

The Machine and Engine.—The *Jason Wanderer* G-AAAH was a De Havilland "Moth" fitted with a "Gipsy" engine. It was originally owned by Capt. W. L. Hope, who used it, amongst other things, for the flight to Kenya and back to bring to London photos of the Prince of Wales. It has, therefore, seen other service besides this flight. **The Magnetos** were B.T.-H., and these functioned perfectly throughout, and only minor trouble connected with ignition entirely outside the magneto itself was experienced. **K.L.G. Plugs** were sparkling as ever.

Hoffmann Ball Bearings were used in the "Gipsy" engine, while the propeller was supplied by the **Airscrew Co.,** of Weybridge, Surrey. As usual, the **Titannie-Emaillite** dope stood up well to the ever-changing climatic conditions, as did the **Dunlop tyres,** and the **Nachmann plywood** supplied by Nachman Kremer and Sons.

Miss Johnson's wonderful navigation throughout the flight was assisted by **Smith's Instruments** supplied by S. Smith and Sons (M.A.), Ltd., and by **Stanford Maps.** The all-important matter of fuel supplies was looked after by **Shell Mex,** and finally **Wakefield's Castrol** helped matters to run smoothly for Miss Johnson.



At Jhansi: An officer helps to start Miss Johnson's engine. (*Times Copyright Photo.*)

"DEA EX MACHINA"

An incident in Miss Johnson's Flight

(*From An Eye-Witness*)

IN *The Times* for May 28 there appeared a delightful little human story of Miss Amy Johnson's adventure at Jhansi, which through the courtesy of our contemporary we are able to record below.

"At 4.30 p.m. on May 11, before the inhabitants of a certain Indian Plains Station had aroused themselves from their afternoon search for sleep, an aeroplane appeared out of the skies. It circled round the station twice, appeared to land, rose again and departed in an easterly direction.

"About half an hour later, the station now being awake again, the Colonel, standing on his verandah, undecided whether to ride or watch the hockey match, suddenly espied the 'plane coming from the East. As he watched it he saw that all was not well with it. Hastily, he gathered twigs and dry grass and attempted to light a fire, hoping that the column of smoke would indicate the wind's direction and help the aviator to land.

"But it was too late—the 'plane was down. Down on the regimental parade ground and charging at high speed towards the barracks. It twisted its way round trees, barely missed an iron telegraph post, scattered a group of men waiting to mount guard, smashed into the name board outside the regimental office, and then came to rest wedged between two of the barrack buildings. There was a race to reach it.

"From the cockpit climbed a figure. It was a girl—young, almost a child, fair, wearing only a shirt, an ill-fitting pair of khaki shorts, socks and shoes, and a flying helmet. The skin on her face, arms and legs was burnt and blistered by the sun, and tears were not far from her tired eyes. The Colonel, advancing towards the unexpected visitor, with a welcoming smile, said :—'Good afternoon, Miss Johnson!'"

"'I am two days ahead of Bert Hinkler's time so far,' she said, 'and now I'm afraid everything is ruined.' Inspection of the 'plane, however, revealed that the damage was not irreparable, and a new light of battle appeared in her eyes.

"There was much to be done. The broken wing must be mended, the old oil replaced by new petrol procured and poured into the almost empty tanks. Nuts and screws must be tightened and adjusted, and the sparking plugs changed. By this time a little army of willing helpers had collected, and each proudly played his small part in this epic of the air.

"About 9 p.m. a halt was called. Miss Johnson was rushed in a car to a bungalow near by, where a bath and a change of clothing awaited her. Then dinner—no elaborate banquet. 'I left London six days ago,' she said, 'and haven't once had more than three hours' sleep.' And a little later, 'This is my first meal to-day.' Wine was passed round and a simple toast was drunk to the heroine. The mess visitor's book was produced and, for the first time, a woman's name was inscribed on its pages.

"Then back to the cars and up to the Lines to make all ready for an early start the next morning. A small crowd of Indian women had collected round the 'plane. They begged that this 'Miss Sahib' would just touch them with her hand, a request which, tired as she was, Miss Johnson cheerfully acceded to. Then while she slept on a chair, later replaced by a 'charpoy,' mere man proved himself capable of filling-up with the 42 gallons of aviation spirit—and all was ready.

"Refreshed by sleep, cheered by the goodwill and heartfelt admiration of her fellow-countrymen, early the next morning Miss Amy Johnson made a perfect take-off for her next hop to Calcutta."

8876

THE FOKKER F.IX. : This machine has recently been put on the England-Holland service by the K.L.M.
(FLIGHT *Photo.*)

THE FOKKER F.IX

Three "Jupiter" Engines

ONE of the most progressive airlines in Europe is the K.L.M. (Royal Dutch Airlines), and it is quite in keeping with the policy of the company to lose no time in putting into service the latest and most up-to-date machines as soon as these become available. It may be recollected that last autumn Mr. Anthony Fokker paid a short visit to England, arriving in his latest type of commercial machine, the F.IX. This machine has now been acquired by the K.L.M. and put on the England-Holland air route. Last week we published a photograph of the cabin of the F.IX, which is quite unusually comfortable, what with its well-upholstered seats, adjustable head rests, ample leg room, and comparatively little noise. The days when, as Captain Hill put it, operating companies were content to "charge double first-class fare for fourth-class accommodation" are rapidly disappearing, and the Fokker F.IX marks a new milestone along the road to really comfortable, as well as rapid, air transport.

Although of typical Fokker lines, and with a strong resemblance to the famous F.VII 3 m., the F.IX is something rather more than a mere enlargement of the older type. Of the more important changes it may be pointed out that the pilot's cockpit is farther forward, with a corresponding gain in view, while the rear portion of the fuselage has been raised so as to get a more favourable angle for landing.

In the matter of structural features, the Fokker F.IX is quite similar to previous models, the two main forms of construction employed being all-wood wing and welded-steel tube fuselage.

The Fokker methods of construction being so well known it is superfluous to go into details concerning them, and one may at once turn to the features which will most interest the operator and user of aircraft. From the former's point of view, such items as ratio of gross to tare weight, range, cruising speed, pay load and so forth, are the most interesting. The F.IX, as fitted with three Gnome-Rhone "Jupiter"

FOKKER F.IX

Three "Jupiter" Engines

Dimensions	
Length o.a.	63 ft. 4 in. (19·3 m.)
Height	15 ft. 9 in. (4·8 m.).
Wing span	89 ft. (27·15 m.).
Wing area	1,109 sq. ft. (103 m.²).
Wheel track	23 ft. (7 m.).
Length of cabin	19 ft. (5·8 m.).
Width of cabin	6 ft. 11 in. (2·1 m.).
Height of cabin	6 ft. 3 in. (1·9 m.).
Capacity of :—	
Cabin	812 cu. ft. (22·7 m.³).
Forward hold	49·5 cu. ft. (1·4 m.³).
Hold under cockpit	35·3 cu. ft. (1 m.³).
Aft hold	113 cu. ft. (3·16 m.³).
Lavatory	82 cu. ft. (2·29 m.³).
Engines	
Type	Three Gnome-Rhone "Jupiter" Mark VI
Maximum power (each)	500 b.h.p.
Maximum revolutions	1,800 r.p.m.
Cruising power (each)	334 b.h.p.
Cruising revolutions	1,750 r.p.m.
Fuel consumption :—	
At full power	3 × 251 lb. (114 kg.) per hour.
Cruising	3 × 181 lb. (82·3 kg.) per hour.
Weights	
Tare (fully equipped)	12,012 lb. (5,460 kg.).
Crew (2)	353 lb. (160 kg.).
Fuel (approx. 5½ hrs.)	2,953 lb. (1,340 kg.).
Oil	286 lb. (130 kg.).
Passengers and luggage	4,232 lb. (1,925 kg.).
Gross weight	19,836 lb. (9,000 kg.).
Wing loading	17·8 lb./sq. ft. (87·25 kg./m.²).
Power loading	13·2 lb./h.p. (6 kg./CV).
Performance	
Maximum speed	130 m.p.h. (210 km./hr.).
Cruising speed	107 m.p.h. (172·5 km./hr.).
Minimum speed	67 m.p.h. (108 km./hr.).
Climb to 3,280 ft.	1,000 m. in 7 min.
Climb to 6,560 ft.	2,000 m. in 16·5 min.
Climb to 9,840 ft.	3,000 m. in 31 min.
Service ceiling :—	
Gross wt. 8,000 kg.	15,416 ft. (4,700 m.).
Gross wt. 9,000 kg.	11,808 ft. (3,600 m.).
Absolute ceiling :—	
Full gross weight	On 2 engines, 3,936 ft. (1,200 m.)
Range, normal tankage	590 miles (950 km.) in 5½ hr.
Range, full tankage	715 miles (1,150 km.) in 6·3 hr.

Both these ranges refer to still air.

Take-off run	820 ft. (250 m.).
Landing run (brakes)	900 ft. (275 m.).

These performances are guaranteed by the Fokker Company within the following margins: 1½ per cent. on tare weight, 3 per cent. on speeds, and 6 per cent. on climbs, provided engines develop power stated.

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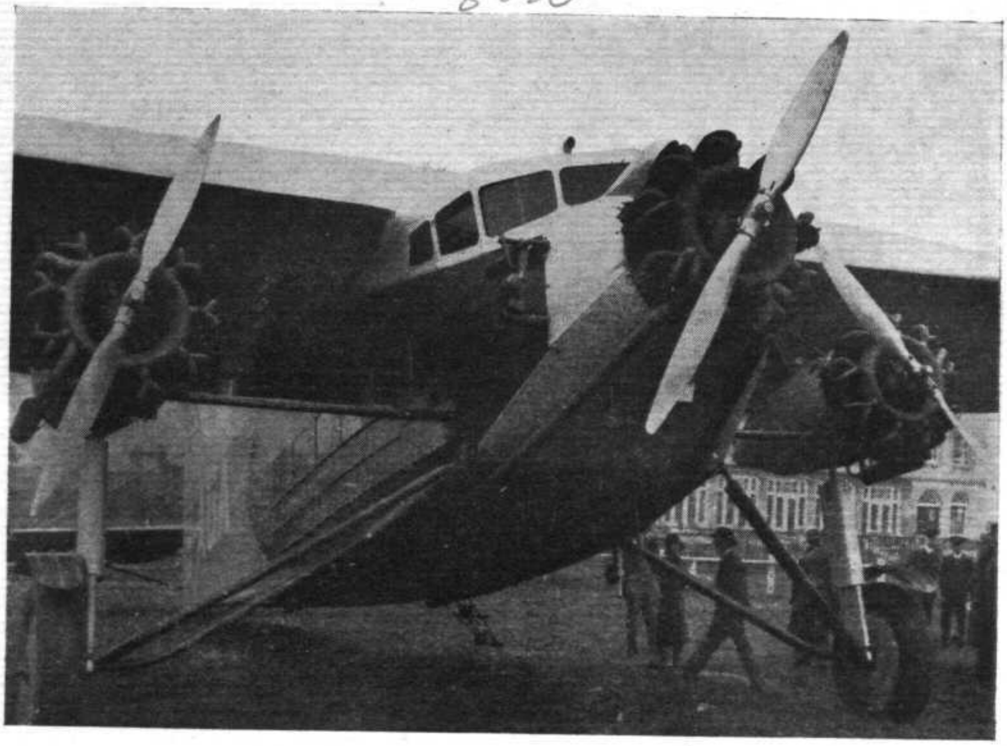

Nose of the F.IX. : The engines are "Jupiters" of 500 h.p. each. Note the windows around the pilot's cockpit, which give protection without loss of view. The undercarriage is of the usual Fokker type, with numerous endless rubber rings as the shock-absorbing medium. Wheel brakes are fitted. (FLIGHT *Photo.*)

engines, and fully equipped to carry two pilots and 18 passengers, has a tare weight of 12,012 lb., while the gross weight is 19,836 lb., which gives a ratio of gross to tare weight of approximately 1·65, a figure which must be regarded as good for a machine of this weight. The manner in which the disposable load is apportioned will, of course, depend upon the sort of route and service for which the machine is wanted. The disposable load corresponds to some 5·2 lb./h.p. on maximum b.h.p., and to 7·8 lb./h.p. on cruising b.h.p. With

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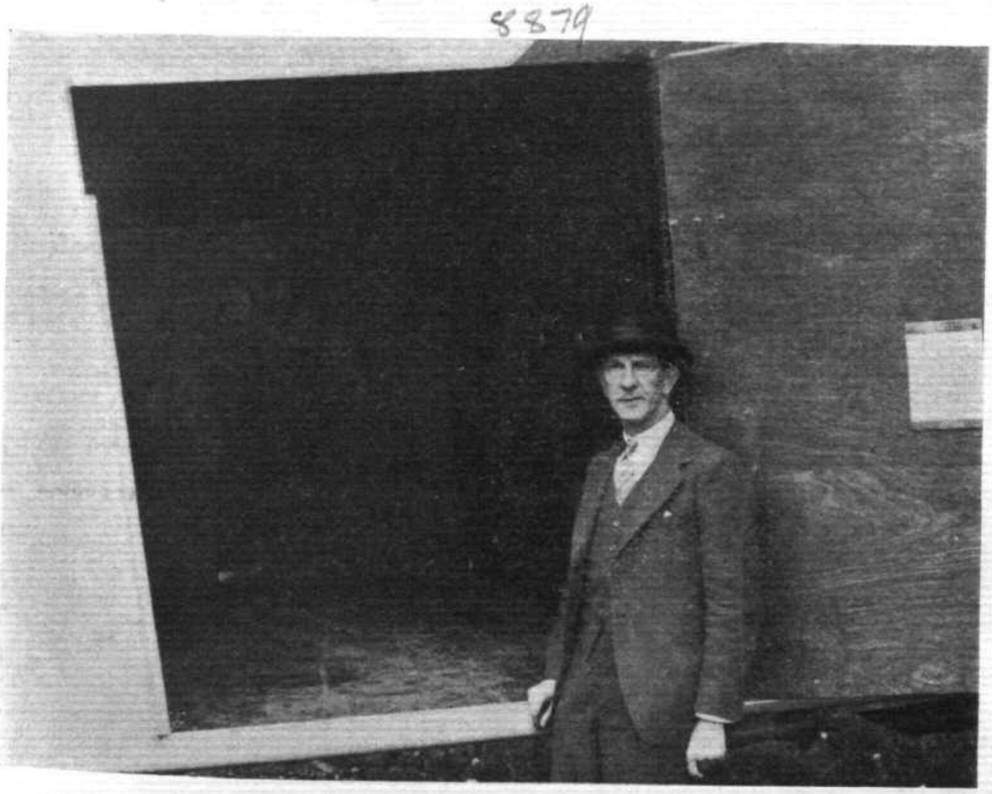

The illustration above shows the F.IX. in three-quarter front view. The people walking about near the machine give a good idea of the size. On the left, a view into the luggage compartment, which is exceptionally roomy. (FLIGHT *Photos.*)

fuel and oil for approximately 5½ hours, and a crew of two, the actual pay load is 4,232 lb., which corresponds to 2·82 lb./h.p. on maximum power and to 4·2 lb./h.p. on cruising h.p. And this is for a still-air range of approximately 590 miles, at a cruising speed of 107 m.p.h. For routes requiring shorter stages, the pay load can, of course, be correspondingly increased. Or conversely, by reducing the pay load the stages can be increased. The pay load of 4,232 lb. corresponds to 18 passengers at 160 lb., plus 1,352 lb. of luggage, mails, etc.

Sufficient has probably been said to show that the F.IX is a machine which should appeal to airline operators, as it combines

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Three-quarter rear view of the Fokker F.IX. (FLIGHT *Photo.*)

good performance with a considerable pay load. From the point of view of the passenger who will make use of it, the Fokker F.IX would appear to be an equally promising type. The cabin is large, well lighted and well ventilated.

The seats for the 18 passengers are arranged in three fore-and-aft rows, a single row along the port side and a double row to starboard. The seats themselves are of tubular construction, with leatherette covering and comfortable arm rests. A vertical strap or web runs along the back rest, and on this strap the head rest is mounted in such a way as to enable it to be readily moved up or down until the position most comfortable for the particular passenger is found. Anyone who has made a flight of some hours' duration will know that no seat of fixed parts remains comfortable for any length of time. A change of attitude is needed every so often. In the Fokker type of seat the adjustable head-rest provides a variety of comfortable positions, and can be made to suit tall and short alike.

In the forward wall of the cabin is a door leading to the pilots' cockpit, which in itself is large and extremely well lighted by sliding windows and windscreens. The view is very good, so that what with the provision of dual controls, the crew should work under very favourable conditions, a matter the importance of which is not always fully realised. Probably nothing is so worrying to a pilot as a poor view. When, therefore, the view is good, as in the F.IX, the pilots' cabin is otherwise comfortable, and side-by-side seats and dual controls are provided, the crew is likely to be able to work efficiently, and the risk of accident of any kind is reduced.

The data, etc., likely to interest the aircraft operator and the aircraft engineer will be found in the table on p. 580.

CHOSEN AFTER LONG DELIBERATION

The Hawker "Hornet" Adopted

TO those who have followed closely the progress of the H. G. Hawker Engineering Co., Ltd., during the last few years it must have become obvious that here is a firm which is determined to be in the very front rank of British aircraft constructors. That the Hawker company has not only maintained the place which its predecessor, the Sopwith company, carved out for it, but has forged ahead and won for itself during recent years a position in the very forefront, is due to the initiative and calm judgment of the firm's joint managing directors, Mr. T. O. M. Sopwith and Mr. F. Sigrist, and to a very highly skilled technical staff headed by Mr. Sydney Camm. Nor should one forget the part played by Mr. Bulman, the firm's chief test pilot, whose reports and advice must have been of the very greatest value in the evolution of new types of aircraft. The good team work of those mentioned, ably backed by the rest of the staff and workmen, has not been long in bearing fruit, and the H. G. Hawker Engineering Co. has done right well in recent times.

FLIGHT) (*Photo.*

The aviation community in general has long been aware that a hard competition has been going on for the honour of being the first firm to be entrusted with the production, for the Royal Air Force, of a single-seater fighter of the interceptor class. Of the inner history of that competition one may not write in detail, but it is probably fairly general knowledge that in the end this competition narrowed down to a choice between two machines, produced by different firms. One of these was the "Hornet." How little there was to choose between the two machines is shown by the length of time taken by the authorities in coming to a decision. We who have been permitted to know a little of the "struggle" realise that it must indeed have been a difficult matter to make a choice, so evenly were the two machines matched. The two firms concerned will be the first to admit that "it was a good fight," and the Hawker Engineering Co. has the satisfaction of knowing that it has beaten a worthy rival.

The interceptor class of machine is, as the name implies, intended for intercepting hostile aircraft, and high speed at great heights, with an almost phenomenal rate of climb, are the main performances to be aimed at. Finally, it should be recorded that the "Hornet" is fitted with the Rolls-Royce "F" type supercharged engine, which has contributed so much to the success of the machine.

AIRSHIPS

A CRUISE OF R 100

Visit to Canada Postponed

TO stand on Boar's Hill and see the spires of Oxford rising from the plain below ; to gaze out of the window of the train speeding north from Calcutta and catch the first glimpse of the snow-clad crest of Kanchanjunga towering above the Himalayan foothills—these are sights which make an impression on a man. But an experience worthy to be ranked with those sights is to drive through Hitchin and Shefford to Cardington, and as the car tops the last hill to sight an airship moored to the tower, with the sinking sun gleaming on the silver fabric. First, the curve of the monster's back shows between the rows of trees, and then the whole imposing bulk of the ship comes into view. Wednesday evening, May 21, was just perfect for giving full effect to the grandeur and beauty of R 100. The only factor which was not aesthetically perfect was the mooring tower. Its 200 ft. of stately height was dwarfed by the length and girth of the airship ; and it seemed an indignity for the giant to be tied by the nose to such a stump. It reminded one of a large St. Bernard dog, not muzzled, but under the control of a very small child.

The engines were all ticking over as I approached, and as each propeller runs clockwise, the two screws of each car run in opposite directions, which gives a curious effect to the eye. These were all new engines, Condors 3B, installed since the last flight, and this was to be their first trial run. As a matter of fact, they all behaved perfectly. Then all the engines were stopped except the forward one in the port wing car. When the weights which hold the tail down were cast off, the passenger hatch rose two or three feet clear of the embarking platform, and one or two of the crew who were late in going on board had to perform a mild gymnastic feat. But that is nothing to an airship hand. While waiting for the start, members of the crew thronged down on to the engine cars and stood on the top, disdaining to hold on to anything, with the utmost *sang froid*. The 24 passengers had gone on board before.

The most important passenger was Mr. Montague, Under Secretary of State for Air. Other passengers were Sir Dennistoun Burney, Sir Harry Brittain (who did not seem in the least apprehensive of engine failure), Sqdn.-Ldr. Shearer, the Canadian Liaison Officer at the Air Ministry, and Group-Capt. A. V. Bettington, C.M.G., the officer commanding the Henlow Depot, whose men have done yeomen service in providing ground handling parties. The crew numbered five officers and 36 ratings, under the command of Sqdn.-Ldr. R. S. Booth, A.F.C., the captain of the ship. The total number of souls on board was 65.

The most important person not on board was Maj. G. H. Scott, C.B.E., A.F.C., the officer in charge of flying and training. He had decided to leave the captain of the airship in sole command for this flight. As he stood on the ground, looking up at the ship, he remarked to the representative of FLIGHT, "I have not watched a British airship in the air since 1921, when I saw R 36 flying." The fact that he felt able to stay on the ground shows the confidence which he now entertains for the officers and crew of the R 100.

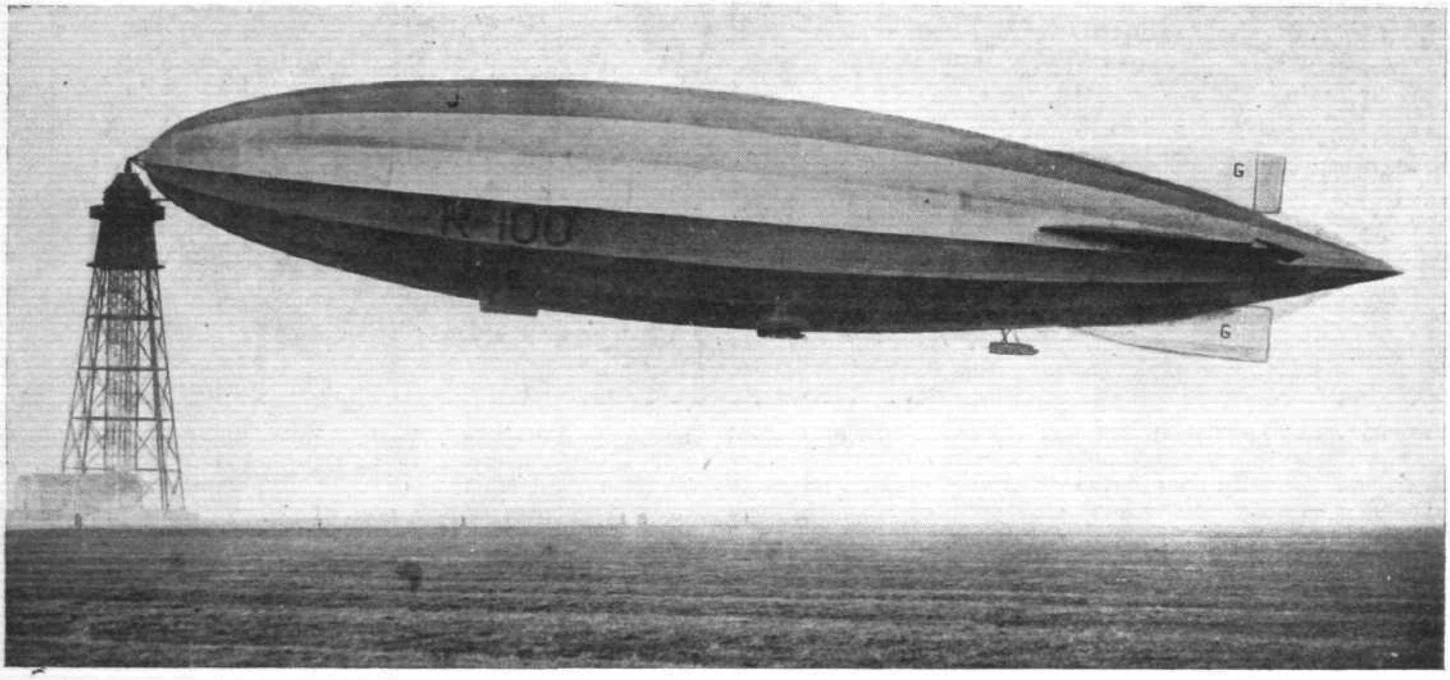
The special objects of the flight were three. One was to the test the new engines. The second was to practise the wireless reception on the ship of complete weather charts from the meteorological office at Cardington. This had been tried before with a ship at the Royal Aircraft Works, but there had been no previous transmission of maps to a ship in flight. The third was to test the short wave wireless reception, as R 100 was to receive messages from Malta and Baghdad. In all three respects the results of the flight were quite satisfactory.

The general orders given to the captain were to make for the Wash and spend the night cruising in the North Sea. On the following (Thursday) morning he was to come inland and pass over Hull, York, Leeds, Sheffield, Manchester, and Liverpool, returning to Cardington about 5 p.m. on Thursday, the 22nd.

At 2 minutes past 7 p.m. the nose of the airship was slipped from the head of the tower and rose clear. For a second or two it rose faster than the tail, but no reports were received of teacups slopping over. Water ballast was promptly discharged from near the tail, and the ship immediately righted herself. It was noticed that the fabric rippled in the slipstream of the propellers. Twice she cruised round the station, and then headed off for London. Mr. Montague, it seems, had expressed a wish to fly over his constituency of West Islington, and his desire was gratified. Londoners got a beautiful view of the airship in the pink-tinged evening light. Sqdn.-Ldr. Booth dipped the nose of the ship over Buckingham Palace, desiring to salute the King. He saw a group of people in the Palace grounds, and supposed that they were the Royal party. As a matter of fact, the King and Queen were at that moment going to the opera at Covent Garden, but the captain did not know this. From the ground, however, it is not easy to say when an airship is exactly over any particular point, and Londoners were convinced that the ship dipped her nose exactly over the Opera House. On leaving London she travelled over Southend, which by that time was lighted up and looked very fine from the air. Dinner was then served, and the passengers lost interest in the views, for the dinner was a good one. At 10 p.m. most of the passengers went to bed. Mr. Montague said that he slept better on board than he usually sleeps, and did not wake till 6.45 next morning. The passengers slept in sleeping bags on the bunks, and found them comfortable. The only complaint was that the radiators were not turned on, and had they not taken plenty of thick clothes with them they would have felt the cold before they went to bed. Truth to tell, it was not very warm on the ground on Wednesday and Thursday. The explanation given was that one of the A.C. auxiliary engines was wanted for the cooking range and the other for the wireless. The captain explained afterwards that it was more important to have his wireless in action than to keep the passengers warm. This is very true, and the captain could not have done otherwise than he did. At the same time, if a passenger airship is to win popularity it must provide for the comfort as well as the safety of its passengers, and the provision of power to work the radiators is a point which calls for attention.

During the night, tests were carried out to tell the direction and strength of the wind by dropping calcium flares, which worked very well. The airship beat up to the north, flying sometimes 40 to 50 miles out to sea. Mostly, the ship kept at a height of 2,000 ft., with an occasional maximum of 3,400. The usual speed was about 54 knots, but for three hours the ship was kept at 70 m.p.h., and once she was sent up to full speed of 80 m.p.h. for 10 min. During most of the cruise the fuel consumption was being tested. A certain combination of engines was chosen, and the ship was run on them for a period of three hours. Then another combination would be tried. The actual weights taken on board at the start were $22\frac{1}{2}$ tons fuel and 15 tons water ballast. For the Atlantic flight it is proposed to take 36 tons of fuel.

The weather kept clear till 2 or 3 a.m., and then it grew misty. During the night the ship cruised up as far as Flamborough Head, and then turned and worked southwards down the coast again. At 7 a.m., when Mr. Montague and Sir Harry Brittain woke up, they found themselves between Southwold and Lowestoft. During the night, Sqdn.-Ldr. Booth slept in the captain's quarters. He got up three times during the night to satisfy his own curiosity, but found that all was well and that he need not have disturbed himself.



"Not muzzled, but under control." (FLIGHT *Photo.*)

The officers of the watch were functioning like the proverbial book. Passengers had breakfast at 8 a.m., and about that time the airship turned inland over Hull. She was well seen from the towns of Yorkshire and Lancashire, and she was well up to time in arriving over Manchester by noon. From the air the view was not so good as it was from the ground. Mr. Montague admitted that he found flying through mist "a little tiresome." But when there was nothing to see through the windows, he said that the passengers interested themselves otherwise. There was a suggestion of playing cards, but no one would admit the soft impeachment. All the passengers in turn were taken over the ship, into the control car, where some of them were allowed to take the steering wheel, and along the "catwalk" of the hull up to the tail. Sir Harry Brittain found that a very interesting experience. He said that everything was very still indeed until suddenly one came to a certain spot over an engine car, and then one heard the roar of the engines quite loudly. All were emphatic about the absolute steadiness of the ship and the absence of vibration and distracting noise. Mr. Montague described the trip as "calm, peaceful, uneventful." The Under-Secretary is an old soldier and an old journalist, and he likes excitement. He gave it as his personal feeling that he prefers travel by aeroplane because he finds it more exhilarating, and he likes the sensation of speed, which one does not get in an airship. Probably, most prospective travellers will think Mr. Montague's criticisms a recommendation. The Under-Secretary added that he would very much like to fly to Montreal in R 100.

While R 100 was still in the air the Canadian Department of National Defence cabled to Lord Thomson, asking that the flight to Montreal might be postponed until after the Canadian Parliament had risen at the end of May, as many Ministers and Members of Parliament wished to be at Montreal to see the airship arrive. Lord Thomson at once cabled back, agreeing to the suggestion. The change of plans was news to those on board when they landed.

At 4.30 p.m., on Thursday, the airship came back over Cardington. The officers on board were very surprised to get a message from the station: "Suppose you know your tail is buckled." They knew nothing of the sort. But it was a fact. The fairing behind the last transverse frame, a member some 20 to 30 ft. long, was badly buckled. It is supposed that it must have collapsed during the 10 min. run at full speed, when the air pressure on that member would be considerable. It is a member which does no work beyond completing the streamline shape of the ship, and apparently it did not receive enough attention from the stress-calculators. But its collapse did not in any way affect the handling of the airship, and Booth was very surprised to be told that it had happened.

It was as nasty an evening for mooring as could well be imagined. The wind was blowing in sharp vicious squalls, with frequent bursts of heavy rain which added a couple of tons to the weight of the ship until the wind dried off the moisture. Occasionally, the sun would break through, but not sufficiently to expand the gas rapidly. The first time the mooring cable was dropped the rain stopped suddenly and the ship rose, so that she had to be put about and brought in again. Booth handled her very skilfully, indeed, though afterwards he said in an apologetic tone: "You see, none of us has had much airship practice for the last ten years." The second attempt was successful, and the ship's cable was attached to that from the tower at 4.45 p.m. Then the engines were stopped, the elevators were kept raised, and Flying Officer H. G. Cook, D.S.M., took chief charge from the head of the tower. The direction of the wind was also as awkward as it could well be, the ship coming in over the top of the office sheds round the base of the tower. The side guys had to be carefully handled over the roofs of the sheds before they could be attached to the bollards, and to add to the discomforts of those on the ground, the fires in the winch houses were smoking abominably. At the Ismailia tower all the huts and winch houses are inside the perimeter of the tower, which is the ideal arrangement. For an hour and 10 min. F./O. Cook played R 100 as an angler plays a fish, easing her off when a squall caught her bows, and seizing every opportunity to wind her in. I fancy that a sea pilot who has had to bring a large liner into dock in difficult circumstances would have admired the skill with which this operation was carried out. At last, the dewdrop was locked safely home into the mooring cone, and at once a megaphone from the control car began to demand that the ground party should hurry up with the four weighty wheels to hold the tail down. The tractors got busy. Again the hatch did not fit quite perfectly on to the embarking platform, and hands had to assist the passengers to disembark. The passengers did not very much enjoy it. R 101 fits very much better. None the less, opinions were unanimous that the flight had been most enjoyable.

On Monday, May 26, R 100 was taken back into her shed for examination of the damage to the tail and for necessary repairs.

It was found on examination that the fairing of the tail piece had been made of too light a gauge, and a new one will be made in a heavier gauge. It was also found that the fabric cover had given way in a bay behind one of the power cars. This will be remedied by fitting an intermediate girder at this spot, a step which has proved an effectual remedy at other places in the ship. The flight to Canada has accordingly been postponed until the end of June or the beginning of July.

THE ENGINES OF R 101

The new transverse ring which is to be inserted into R 101 behind the passenger quarters, is now being assembled. The ship will have to be inflated for the operation, as the two ends will be floated apart. It is hoped to make a couple more

flights over Great Britain before the new ring and gas bag are inserted. These trips will be useful for engine testing.

Efforts are now being directed to make two of the engines reverse, as steam engines will do, without the use of gearing. If this is successful it will allow the port forward engine to be used for forward flight, and will also make two engines available for going astern, which is more desirable than having to trust entirely to one engine for this occasional but very important work.

"GRAF ZEPPELIN" FLIES TO BRAZIL

As briefly reported in our last issue, the German commercial airship "Graf Zeppelin" left Friedrichshafen on Sunday, May 18, at 5.25 p.m., and arrived at Seville next day at 5 p.m. Dr. Eckener was in command, and there were on board with him a crew of 42 and 22 passengers. Special stump masts had been sent to Seville and Pernambuco, and erected for the accommodation of the airship. On Tuesday, 20th, the ship started across the Atlantic once more, bound for Brazil. The Infante Alfonso, of Orleans went on board at Seville, and crossed to Brazil in the ship. The start was made at 8.30 a.m. By 4 p.m. that day she reported her position as about 300 miles E.N.E. of Madeira, making slow progress against south and south-westerly winds. Next morning, Wednesday, 21st, the airship established communcation with Rio, Natal and Pernambuco. The water on the airship was reported to have run low owing to the great heat. By 6.15 p.m. (Central European time) the airship was in the neighbourhood of the Cape Verde Islands. On Thursday, 22nd, the "Graf Zeppelin" crossed the equator at 9 a.m., and suitable ceremonies took place on board. At 1 p.m. the airship passed over the island of Fernando Noronha, and at 6.30 p.m. she arrived at Pernambuco, and at 6.30 p.m. she arrived at Pernambuco in Brazil, and moored to the stump mast at the Giquia aerodrome. The crossing of the Atlantic took 59 hr. 53 min. While refuelling there a valve is stated to have exploded, and to have injured a workman. On Friday, 23rd, the airship left at 11.53 p.m. for Rio de Janeiro, a run of 1,120 miles. The trip occupied 26½ hours, and the ship passed over the capital of Brazil at 2 a.m. on the morning of Sunday, 25th.

On her southward flight in Brazil she was delayed by adverse winds. She came down at 7 a.m. on the Campodos Alfonsos, but stayed there for only about two hours, rising again at 8.42 a.m. She circled the city again, and then headed for the north.

She returned to Pernambuco on Monday, 26th, at 8.29 a.m.

After the return of the "Graf Zeppelin" to Europe about Whitsun, further flights will be undertaken, and the following provisional programme has been issued :—

June 16 and 17.—A Swiss trip.

June 18 or June 19.—Airship has been chartered by the Automobile Club Vorarlberg for one or two trips.

June 21.—Trip to Bavarian Forest, landing late in the afternoon at Munich. Fare R.M. 400. In the evening from Munich to Berlin. Fare R.M. 250.

June 22 to June 25.—Trips over Berlin and a trip to Hamburg.

June 25.—Return to Friedrichshafen. Fare R.M. 400.

June 27 or June 28.—Trip to Vienna. Longer journey without any intermediate landing (fare R.M. 600) for "Neue Freie Presse," Vienna.

June 29.—Landing in Munster, Westphalia. Outward journey R.M. 400 ; homeward journey R.M. 300.

July 2.—Trip to the South German Alps. R.M. 400.

Saturday night, July 5—Sunday, July 6.—Trip to Cologne. Fare R.M. 250.

July 6.—Landing early in Cologne. During the day, trip over the Rhine ; fare R.M. 500. In the evening, landing in Cologne, return night journey to Friedrichshafen ; fare R.M. 250.

July 8 until about the 11th.—A journey of about forty-eight hours' duration to the Northern Lands as far as Tromsö or the North Cape. Fare R.M. 2,000.

July 12 or July 13.—Landing trip to Neustadt a.d. Hardt. A landing in the morning and a landing in the evening. Fare out or home, R.M. 250. Day trip, fare R.M. 400.

July 15.—Trip to Northern Lands as far as Spitsbergen. Duration about 60 hours. Fare R.M. 2,400.

July 22.—Iceland trip. Duration about 60 hours. Fare R.M. 2,400.

July 29.—Trip to Great Britain and Ireland, weather permitting. Duration, 48 hours. Fare R.M. 2,000.

August 2 or August 3.—Trip to Darmstadt, landing there in the evening. Outward trip, fare R.M. 400. Homeward trip, fare R.M. 300.

August 5.—Trip of 60 hours' duration to Madeira and Teneriffe, eventually returning via the Azores. Fare R.M. 2,400.

August 12.—A 48 hours' trip over the Baltic (Denmark, Sweden, Finland). Fare R.M. 2,000.

August 19.—Mediterranean trip (around Italy, Sicily, Adria, Karst), 48 hours' duration. Fare R.M. 2,000.

August 30 or August 31.—Trip to Leipsic, landing there for the International Fair.

The Hamburg-American Line act as agents. It will be noticed that the July 29 trip will be one to Great Britain.

PARACHUTES*

A GOOD book on parachutes was overdue, and we welcome Mr. Dixon's clear description and explanation of all sides of the subject. The parachute was once thought of as a stunt, but now it has quite come in to its own. In fact, every book about fighting in the air makes one exclaim "Oh, the pity of it that these gallant pilots and observers had no parachutes !" The stories of machines going down in flames, or of an unwounded observer crashing because his pilot had been shot, are positively heartrending. Perhaps the most distinguished of American war pilots was Raoul Lufbery. He declared that if ever his machine was set on fire he would jump, and in due course he did so. Had he had a parachute he would have survived ; and the same is true of many, many other pilots and observers. In future wars that one horror, the horror of no escape from a falling or burning aeroplane, will not be repeated.

Mr. Dixon clearly describes the various forms of parachute, the "automatic" and the "Free," and gives clear reasons for his opinion that the latter is the best. He mentions the leading types with impartiality. He describes the methods of packing, of jumping, and of pulling the ring. He describes the sensations of a parachutist, and comfortingly assures us that "parachuting is a tolerable and even pleasant experience." He instructs us how to steer a parachute, and how to avoid being dragged after touching land or water. We sincerely hope that we may never have to put his precepts into practice.

F. A. DE V. R.

* *Parachutes for Airmen.* By Charles Dixon, ex-Observer, R.N.A.S. & R.A.F. (Sir Isaac Pitman & Sons, Ltd. 7/6 net).

"Punch" Summer Number

JUST available, the 1930 Summer Number of *Punch* proves again to be of superlative vintage quality. With such a combination of artists to "draw" upon, it could hardly be otherwise. "Eggsackly on de Equator," an amusing sketch in colour by L. Raven Hill, is a reminder of the recent crossing of the line by the Graf Zeppelin. "Un-named heroines," by E. H. Shepard, is another highly humorous conception, whilst Scotland again contributes some extremely funny situations from the pens of Bert Thomas and Arthur Watts. "What our noble animals have to put up with" (the centre double-page picture in colours) is a very fine example of the versatility of Frank Reynolds. Altogether a wonderful shilling's worth.

AIRISMS FROM THE FOUR WINDS

Air Link from Lancashire to the Continent

THE proposal to start an experimental air service to connect Manchester, Liverpool and Birmingham with the Continent has met with the approval of the General Purposes Committee of Birmingham Corporation. The Lord Mayor has stated that the committee was in favour of providing a subsidy not exceeding £1,000 for the scheme, provided that financial support was also forthcoming from Manchester and Liverpool. The three Lord Mayors will shortly meet to consider the subject.

Kingsford Smith's Proposed Atlantic Flight

SQUADRON-LEADER KINGSFORD SMITH has flown all round the world except from Europe to America. He proposes to complete this last link at the end of June. He has obtained leave from the Government of the Irish Free State to make his start from the Phoenix Park, Dublin. It is stated that he will take the following crew with him :—Mr. Wandyk of the K.L.M. as assistant pilot, Capt. Saul of the I.F.S. Army Air Corps as navigator, and Mr. J. W. Stannage as wireless operator.

Roumanian Prince Killed

PRINCE MIRCEA CONTACUZENO was killed and his wife injured in an aeroplane crash at Bucharest on Monday, May 26. The Prince was a supporter of the exiled Prince Carol, and on the night before his death he had been dropping leaflets from his machine over Bucharest to advocate the return of Prince Carol.

Amphibian Competition at Hull

THE Hull Development Committee is considering a proposal to hold an international competition for amphibian aircraft in the summer of 1931. A suggested course would include Belfast, Liverpool, Hull, Hamburg, Copenhagen, Stockholm and Oslo. That distinguished citizeness of Hull, Miss Amy Johnson, is to be invited to co-operate in the organising of the contest. Such a competition promises to be very interesting, and we sincerely hope that the suggestion will materialise.

The German Gliding Champion

HERR ROBBERT KRONFIELD arrived in England on Wednesday, May 28, as the guest of the British Gliding Association. He has brought with him his Wien glider, on which he established a world's distance record on July 30, 1929, by gliding for 150 metres from the Wasserkuppe to the Fichtelgebirge. Herr Kronfeld hopes to give a display on the north western slopes of the Chilterns on Sunday next, using the Ysögling glider belonging to the London Gliding Club. Later, perhaps on Thursday, June 5, he hopes to give a proper demonstration on his Wien; but before details can be settled he intends to study certain localities and to consult with the meteorological authorities.

West Australian Airways, Ltd.

THE contract held by West Australian Airways, Ltd., for a weekly service between Perth and Derby, is due to expire next June, but Major Norman Brearley has received from the Commonwealth Government an offer to renew the contract for another three years. He stated that it was highly probable that the service would be extended from Derby to Wyndham during the coming winter (*i.e.*, June to September). This extension has been long desired by the people of Wyndham district, but the route is a difficult one to organise.

Major Brearley has also investigated the possibility of extending the East-West service from Perth on beyond the present terminus at Adelaide to Sydney. His company is now in a position to undertake this extension. After leaving Adelaide a stop for the night would be made at Hay, and next morning a call would be made at Canberra. Sydney would be reached at 9.30 a.m. The mails would thus take exactly two days to reach Sydney from Perth. The route between Cootamundra and Sydney, over the Blue Mountains, is also a difficult flying route. Major Brearley proposes to order two new Vickers high-wing monoplanes, each driven by two geared Jupiters, and each capable of carrying 12 passengers.

An airway running Wyndham-Perth-Adelaide-Canberra-Sydney would certainly be the most imposing airway, and one of the most useful, in the world.

Non-Stop Night Flying Air Mails

THE Civil Aviation Section of the London Chamber of Commerce are advocating the inauguration of a non-stop night flying air mail service to some of the more important Continental centres and have placed their views before the Secretary of State for Air. A number of terminal points on the Continent about 1,000 miles distant from London, such as Oslo, Stockholm, Warsaw, Budapest, Rome, Madrid, have been taken as instances, where a machine flying by night at an average speed of 100 miles an hour would enable from 1½ to 2 days to be saved in the delivery of mails, as compared with the ordinary surface methods. This would also include the dropping of mails without landing at important intermediate stations, such as Amsterdam, Hamburg, Copenhagen, Cologne, Berlin, Leipzig, Munich, Prague, Vienna, Paris and Bordeaux among others. It is considered that such non-stop night services would not only effect a speeding-up in the delivery of letters, but would also bring home to business men and others the advantages to be derived from using the air mail. In addition, the institution of fast services like this would obviously benefit the light aeroplane industry in this country. As it is understood that no Air Transport Company in this country has a monopoly for what would be a purely postal service as distinct from mail, passenger and freight combined, the Civil Aviation Section have raised the question as to whether funds would, in fact, be available for such services. Such non-stop night flying services would not be likely to react unfavourably on the development of the two great Empire Air routes to Australia via India and from Cairo to the Cape, which is understood to be the Government's main policy now being carried out by Imperial Airways. The view, that the growth of air traffic will in the near future necessitate the transport of all air mail by night, was strongly expressed at the 23rd Session of the International Air Traffic Association at Stockholm last March. Moreover, as night air mail services have recently been inaugurated by foreign companies between London and Brussels and London and Berlin, it is keenly felt that this country should not be behindhand in any developments that are taking place in this direction.

Scintilla Magnetos in Leeds

WE are informed that Scintilla, Ltd., have opened a Branch Office in the Leeds district, under the title of Scintilla, Ltd., 19-21, Somers Street, Leeds, complete with a fully-equipped Service depot and with a trained technical staff.

SCHNEIDER TROPHY WINNER IN THE AIR AGAIN: The Supermarine-Rolls-Royce "S.6" seaplane, which won the Schneider Trophy last year, being shipped at Southampton en route for the Antwerp Exhibition, where, by permission of the Air Ministry, it will form one of the most important exhibits of the British Section.

The AIRCRAFT ENGINEER

FLIGHT ENGINEERING SECTION

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CONTENTS

THEORETICAL CONSIDERATIONS IN THE DESIGN OF WING STRUT JOINTS

By H. W. V. Steventon, G.I.Mech.E.

With the advent of all-metal construction the aircraft designer has had a number of fresh problems to solve. When he first turned his attention to the design of metal wings, he probably began by worrying mainly about the form of main spar to be adopted. As his experience grew, he probably realised that the spar itself was a relatively simple proposition, and that manufacturing problems were if anything more important than theoretically efficient sections. Having produced a good spar, and ribs to go with it, the next problem to arise was likely to be that of devising a neat method of attaching the inter-plane struts to the spar. Here there is even greater scope than in the design of the spar itself, and it is significant that there are almost as many different types of inter-plane strut attachment joints as there are firms doing metal construction. In the following article Mr. Steventon, who is on the design staff of the Gloster Aircraft Co., Ltd., deals with the theoretical considerations in the design of wing strut joints, and indicates methods that may be employed, with particular reference to metal spars.

Among all the joints of various types which help to form the structure of an aeroplane, those securing the interplane struts and wires have a peculiar interest. In modern British practice their design is bound up with that of the wing spars which are usually made up of some form of corrugated strip metal, and therefore special consideration has to be given to the effects loads may make, and to the shape and attachment of parts of the fittings. Due to their position different loads are put on the joints by each variation in the attitude of the aeroplane, and naturally each joint must be capable of taking its load under all conditions of flight.

The following survey indicates the methods to be employed and the load variations to be anticipated in the design of wing strut joints, particularly as applied to metal spars. The same principles may be used for wood spars, but due to the greater simplicity of attachment possible the elaborations necessary for metal spars may not be required. For aeroplanes of the light plane class a too detailed examination of the variations in load may not be necessary, but as the size of the machine considered becomes larger, greater care must be taken over the possible lines of action the loads may take and the magnitude of any offsets introduced.

No attempt will be made to indicate sizes or shapes for fittings, as these are almost infinite, and the reader interested may easily look up illustrations which have appeared in the pages of this journal.

The name strut joints is given to those centres at which the interplane or body struts meet the wing or centre section spars. Landing, flying, incidence, drag and anti-drag wires and drag struts also meet at the same nominal centre, the actual centre of the fitting being the intersection of the lines of action of all these members on the neutral axis of the spar, in both directions. All the above members may not be present in a joint, the landing wire or flying wire being absent in perhaps 50 per cent. of the designs in actual use.

These members will now be examined with reference to their attachment to the joint, the design of the fitting being of course, bound up in the particular types of members decided upon.

Interplane and Body Struts

The ends of these struts generally terminate in some form of machined end fitting, either an eye-end, or more usually a fork-end, which has to be attached to the strut fitting by a bolt or pin and a corresponding eye-end or fork. These ends are usually arranged in such a manner as to form a universal joint, allowing adjustment of the wings for incidence and dihedral without distorting the fitting, or putting any load other than direct end load on the strut.

Drag Struts

The internal drag or compression struts which join the front spar joints to those on the rear spar may be constructed in a number of ways as follows:

1. They may conform to the aerofoil section and be a braced structure with flanges and web bracing.
2. A braced structure of any convenient depth and design and not conforming to the contour of the wing.
3. Single tubes of steel or duralumin, round, square, oval, etc.
4. Two or more tubes may be used suitably fastened together to resist any torsional load put on the spar by the fitting.

The drag struts perform an important function in the design of strut joints, because, if the strut will prevent any twisting movement of the spar, then certain wires and the interplane strut may be offset from its correct position; the righting moment on the spar being exerted by the drag strut. This is not possible to any appreciable extent with a single tube drag strut, and not at all if the strut is pin-jointed at the

ends. A single tube compression strut may be ideal from the point of view of making and attachment, but it demands that the lines of action of struts and wires should pass approximately through the spar centre when looking along the spar. However, a single tube is frequently used with a strong rib placed near the fitting to take the torsional loads.

Wires

All wires used in general practice terminate in a screwed portion which is secured to either a fork-end or trunnion. The provision for attaching the fork-end to the joint may be a plate lug or a shackle of suitable size spanning the spar or drag strut attachment.

The form of vibration known as "wire flutter" should be remembered when a plate lug is used to secure a fork-end. Modern streamline wires are weaker in a direction at right angles to the path of flight and thus tend to vibrate in this direction, frequently to an extent which may cause the wire to break if it is unduly long for its size. If the plate lug is bent or is flat in the direction of vibration there is a great tendency for the lug to fail in use due to fatigue of the metal taking place.

Diagrammatic Description of a Strut Joint

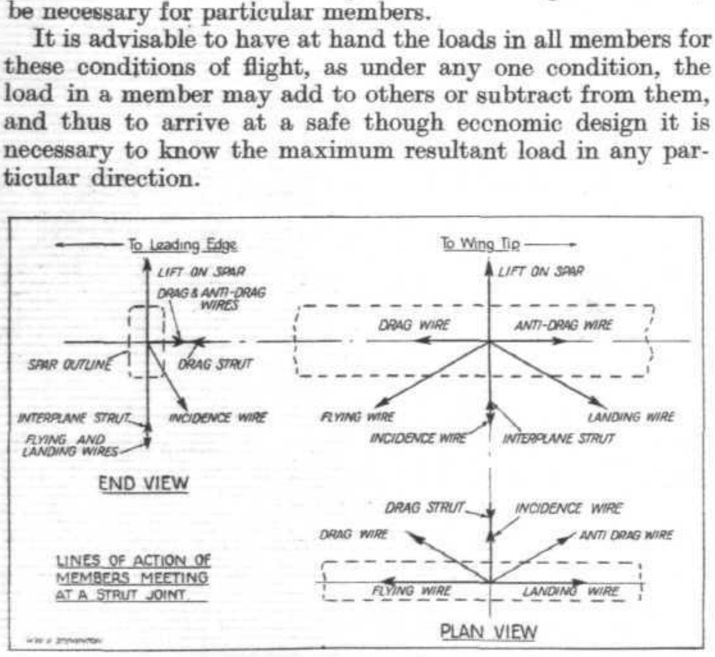
One of the most important points to elucidate in the design of a strut joint is the path taken by the loads in the members in order to ensure that each member is firmly anchored without causing stresses which have not been allowed for.

The following essentials are necessary in order to commence work on the design of a strut joint—the type of spar to be used, the directions and angles of the various members and the loads in all members under the main conditions of flight. These conditions of flight are :—

1. Centre of pressure forward (C.P.F.)
2. Ditto, with front flying wire cut.
3. Centre of pressure aft (C.P.A.)
4. Ditto, with rear flying wire cut.
5. Nose Dive.

In certain cases the landing and inverted flight loads may be necessary for particular members.

It is advisable to have at hand the loads in all members for these conditions of flight, as under any one condition, the load in a member may add to others or subtract from them, and thus to arrive at a safe though economic design it is necessary to know the maximum resultant load in any particular direction.



In the diagram is shown a front spar and the lines of action of wires and struts, assuming the members have no offsets in any direction, and that all their lines of action pass through the centre lines of the spar. This is an ideal arrangement and is a point which might be aimed at when considering the general design of an aeroplane, due to the simple type of fitting which may then be evolved.

Consider this hypothetical fitting under any single condition of loading, for instance centre of pressure forward (C.P.F.). Under this condition the landing wire, incidence wire and one or other of the drag wires will have no load in them, being redundant in the aeroplane structure, and may thus be left out of consideration when stressing for this particular loading.

Coming now to the effects the members and their loads may have upon the attachment to the spar, they may be split up into three important types by taking the component or resolved loads as follows :—

1. Along the spar, parallel to its centre line.
2. Vertically, perpendicular to the spar centre line.
3. Horizontally or fore-and-aft perpendicular to the spar centre line.

These will now be taken in turn, and it will be assumed that the main attachments to the spar are on the front and rear sides. (This is the most common form of joint, and enables a neat fitting to be evolved.)

1. Examining the diagram it can be seen that two members only can have their loads resolved along the spar centre line, these being the flying wire and one drag wire (one drag wire and the landing wire being inoperative). The flying wire load can be split up into two halves running along each side of the spar, while the drag wire load is taken along the rear side only, the wire being attached direct to the rear side. Thus we see that the loads exerted by the fitting on the spar are different on the front and rear sides, and whereas on the front side the attachment must be strong enough to take half the component flying wire load, that on the rear side must be strong enough to take the same load plus the anti-drag wire component load, or it may be relieved to the extent of this load, depending upon which of these two latter wires is in operation under the C.P.F. condition. These loads along the spar are the most important in the joint in that they usually have the greatest magnitude, and it is essential that they should be well cared for.

2. The loads which may be taken vertically are the flying load in the spar, the load in the interplane strut, which are both vertical, and the vertical component of the flying wire acting in a direction opposite to that of the other two. In actual practice it will usually be found that the plates which form the flying wire attachment are a part of, or are directly connected to the strut attachment, and thus the upward load of the strut is taken by the flying wire without actually going into the spar. We are left now with the flying or lift load in the spar which tends to lift it away from the fitting, and this must be taken into consideration as it may cause an undue crushing effect on the spar, or an unlooked-for bending effect on the attachment bolts.

In certain cases the flying wire and strut attachments may be independent, and then each must be effectively secured, while care must be taken that there is a rigid path for the strut load to get on to the flying wire attachment. The strength of the flying wire fixing is generally sufficient for the spar flying load.

3. In the fore-and-aft direction we have the components of the drag or anti-drag wire and the drag strut, and the loads in these members approximately balance. Thus the strength of the attachment required under case 1 is amply sufficient for this case.

There is one important point which should be remembered with respect to these members, and this depends upon the form of drag strut used. If the latter is of the single-tube type lying in the same plane as the drag wire centre line, the consideration does not arise. But if the drag strut is of the built-up type, demanding some form of channel or vertical angle for its attachment, then as the drag wire will be taken off some particular point of this channel, say, in the middle, the channel will be in bending due to the opposing forces in the two members. This may be rather a vital point as if the built-up structure is deep and the channel long, and is unsupported, or only partially supported, by the spar, the bending effect will reach a high value and should be seriously considered in the general design.

The above considerations complete the investigation for the C.P.F. condition which is always the most important for the front spar fittings, as C.P.A. condition is the most important for rear spar fittings. We have as yet taken no loads for the incidence wire or landing wire, because these members come into use under other conditions of loading, and they will now be examined separately.

Incidence Wire

Apart from the negligible loads put on the wire when trueing up the incidence of the wing, this member comes into operation only under a cut-flying wire case, except in centre section fittings, when a nominal load is put upon them. Thus, in the fitting being considered, there will be no load in the flying wire when the incidence wire is acting, and the following form of enquiry arises :—

The loads acting vertically are (1) the flying load (upwards) in the spar, which is central in the spar but may be split up so that half the load is on each of the front and rear sides ; (2) the interplane strut load (upwards), which can also be split up on each side of the spar ; (3) the vertical component of the incidence wire (downwards).

Assuming the incidence wire to be attached at the bottom rear corner of the spar, on its line of action we have rather a curious condition arising. The incidence wire is not offset, so actually the fitting is in a state of static balance, but due to the position of the wire attachment one cannot assume that the load can be split up directly on each side of the spar. The load should be considered as acting all on the rear side, thus counteracting the rear side components of the opposing loads, while the component loads on the front side of the spar transmit their effect to the rear side by the bending of the top and bottom portions of the fitting and the torsional strength of the spar.

Considering the horizontal component of the incidence wire, this can be assumed as acting on the spar centre line, and, with the component of the drag wire, will approximately balance the drag strut load. An examination for bending should be made as for case 3.

Landing Wire

This member generally has its maximum load under the landing case, although it may sometimes occur under nose dive conditions.

The investigation of the effect of the landing wire load is similar to that for the flying wire as already described, the load being split up on each side of the spar and resolved vertically and along the spar in like manner, in conjunction with the various other loads which may be in action at the same time. Generally speaking, as the landing wire load is invariably less than the flying wire load, the spar attachment made for the latter is ample for the former, provided these two members are rigidly joined, and then detail sizes only are wanted for the landing wire attachment.

Final Check

After the fitting has been examined, as described above, for all the main forms of loading which apply to it, the final check has to be made.

Each member is taken separately and its attachment checked for strength in the actual line of action of the load and the final detail shapes and thicknesses determined. Of course, care should be taken when considering this detail attachment to the fitting, that the lines of action of the members are not altered from those taken in the previous investigation.

This now completes the survey into the general principles underlying the design of strut joints, and for the sake of simplicity all members have been assumed as acting with no offsets.

The complications arising through some or all of the members meeting at a joint being offset or inclined have not been taken into account, but most of these can be solved by the methods described. All members, excepting the drag strut, are usually attached by pin-joints, and thus each load can be split up into its various components at these points along the three directions previously examined. With a member inclined to the three planes already taken this will give an additional component to the two components already considered, and naturally this load must also be effectively catered for. The main effect of inclining or offsetting a member is to introduce local bending stresses in the fitting, necessitating greater robustness and thus additional weight.

The fundamental idea to be remembered is that all forces should approximately balance out, and that the only actual loads on the spar should be the flying load in the spar due to the lift on the wing and the end loads due to any members having components along the spar.

As regards the separate parts of the fitting, the main aim to be arrived at is lightness in weight combined with sufficient strength and rigidity. This has to be obtained with the minimum number of separate parts feasible, and each part should be as simple and as cheap to manufacture as possible, and also ease of assembly on to the spar should not be overlooked. It is for these reasons that strut joints require the detailed examination described above, enabling one to design a joint with the minimum of superfluous metal.

THE TRANSVERSE STABILITY OF FLYING-BOAT HULLS

By J. H. LOWER, A.F.R.Ae.S., A.M.I.N.A.

Mr. Lower is no newcomer to our pages, having contributed several articles to previous issues of THE AIRCRAFT ENGINEER. *Mr. Lower, it may be recalled, is in charge of the Experimental Tank of Short Brothers, of Rochester, the producers of many famous flying-boats, and more recently he has been put in charge of the design and construction of seaplane floats, wing-tip floats, etc., so that he is writing on a subject upon which he works every day, and with which he is thoroughly familiar.*

The normal type of flying-boat constructed in this country consists of a central hull, which is transversely unstable due to having a negative metacentric height (GM), with some form of wing-tip float attached that permits of a required degree of stability being obtained.

The writer has found that this required degree of stability, and consequently the size of the wing-tip floats to be used, has formed an interesting yet controversial subject, particularly during recent times and among those more directly concerned with the design of present-day large machines.

In the design of the larger types of wing-tip floats particularly, due consideration must be given to the displacement required and the shape, in conjunction with the aerodynamic and hydrodynamic characteristics.

If "d" is the wing-tip float displacement required for a machine of weight "w," then for a machine of weight "W"

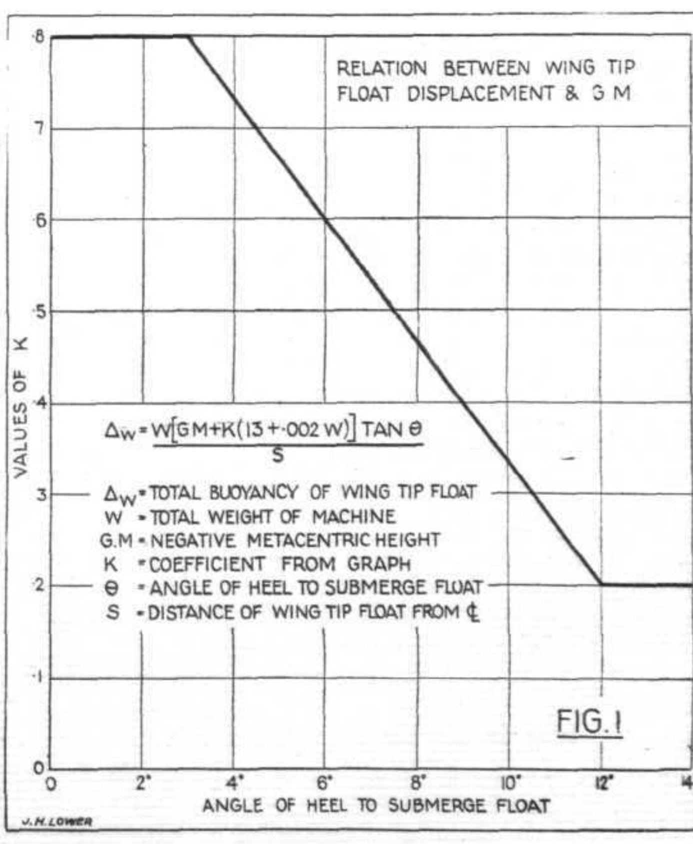


FIG. 1

the corresponding float displacement " D " is given approximately by :—

$$D = d \times \left(\frac{W}{w}\right)^{4/3}$$

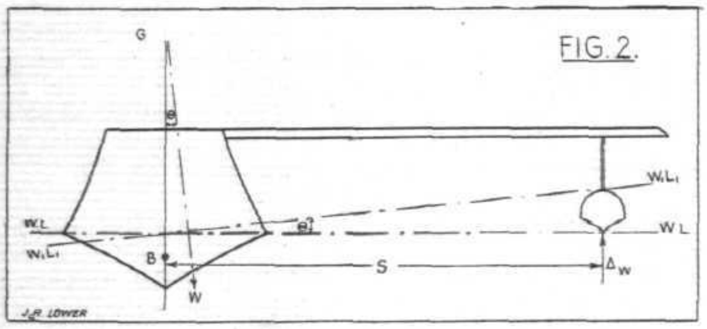
and from this it is clearly seen that the linear dimensions of the floats increase at a greater rate than those of the main hull.

This is of interest, since a formula for determining the required displacement of wing-tip floats which has been widely used is :—

$$\Delta_w = \frac{W}{S}\left[\,GM + K\,(13 + 0{\cdot}002\ W)\right]\tan\theta$$

where

Δ_w = total displacement of one wing-tip float required
W = all-up weight of machine
G.M. = negative metacentric height of central hull
θ = angle of heel to submerge wing-tip float
S = distance of float from centre line of machine
K = coefficient as determined from curve shown in Fig. 1.



By reference to Figs. 1 and 2 it would appear that, according to the shape of float adopted, a wide range of displacements required may result by using this formula, since with a deep float the angle of heel " θ " is large and the coefficient K is small, while with a shallow float θ is small and K is large, and although the term " tan θ " increases, it is obvious that the resultant wing-tip float displacement required is not necessarily increasing with increased values of θ.

As an example, consider a typical flying-boat of the following particulars :—

W = 20,000 lb.
G.M. = − 5 ft.
S = 28 ft.

The wing-tip float displacements required by the formula, assuming float depths of such dimensions as to give different values of θ, have been calculated, and are as follows :—

$\theta°$ ..	3	$4\frac{1}{2}$	6	$7\frac{1}{2}$	9	$10\frac{1}{2}$	12
Δ_w ..	1,780	2,370	2,760	2,945	2,925	2,720	2,370

These results are shown plotted in Fig. 3, and it will be seen that in the case considered, as the angle of heel increases above 8°, the required wing-tip float displacement decreases rapidly. This appears, therefore, to be, obviously, an incorrect assumption; even if only the upsetting moment $W \times BG \sin\theta$ be considered (Fig. 2), and taken to a limiting case where a float of very small beam and large depth were adopted, the result would be absolutely impossible.

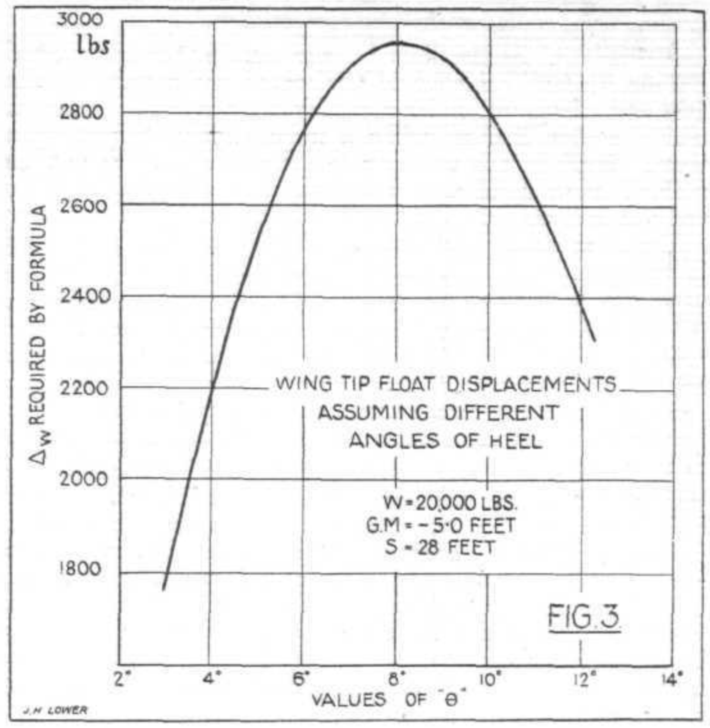
In view of the foregoing, the author has investigated this question of wing-tip float displacements along somewhat different channels, and it would appear that the method outlined leads to an assumption which agrees with known machines, covering a large range of all-up weights, that have been proved in actual practice to be sufficiently stable, and which can be applied with a reasonable assurance of safety to the large flying-boats of the future.

Referring to Fig. 2, it has been assumed that for transverse equilibrium

$$W \times BG \sin\theta = \Delta_w \times S,$$

from which, for any angle of heel to submerge the float, a proportional Δ_w is obtained.

The actual wing-tip float displacement for the machine is



now assumed to be 4 Δ_w, this being a factor which experience has shown to give reasonable stability.

Let $D = 4\ \Delta_w$.

Referring to Fig. 4, assume that these wing-tip floats give to the machine a positive G.M. of the required degree.

The righting moments may be written as :—

$$W \times GM \sin\theta = D \times S,$$

$$\text{or } D = \frac{W \times GM \sin\theta}{S} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(A)}$$

Experience with actual machines has shown that a suitable value for GM may be taken as :—

$$GM = K\sqrt[3]{W}$$

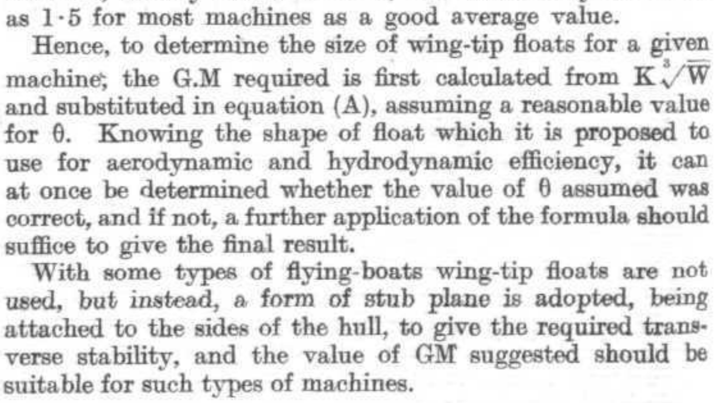
where

GM is in feet,
W is in pounds,

and K is a constant depending on the upper structure of the machine, usually about 1·3–1·8, and which may be taken as 1·5 for most machines as a good average value.

Hence, to determine the size of wing-tip floats for a given machine, the G.M required is first calculated from $K\sqrt[3]{W}$ and substituted in equation (A), assuming a reasonable value for θ. Knowing the shape of float which it is proposed to use for aerodynamic and hydrodynamic efficiency, it can at once be determined whether the value of θ assumed was correct, and if not, a further application of the formula should suffice to give the final result.

With some types of flying-boats wing-tip floats are not used, but instead, a form of stub plane is adopted, being attached to the sides of the hull, to give the required transverse stability, and the value of GM suggested should be suitable for such types of machines.

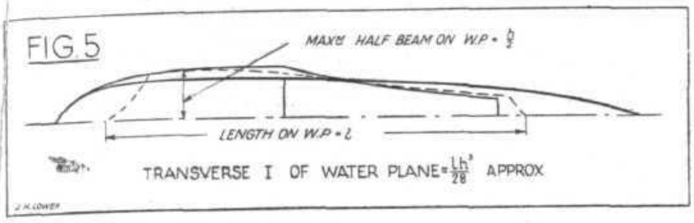


Hence, the method to adopt would be to calculate BM from :—

$$BM = \frac{I}{V}$$

and since BG would be known, then

$$I = V\,(BG + K\sqrt[3]{W}) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (B)$$



It is of interest to note that the transverse moment of inertia of the water plane for the central hull of a flying-boat of normal shape approximates to :—

$$I_H = \frac{lh^3}{28} \text{ (see Fig. 5)}$$

where l = length of water-plane measured along centre line of hull

h = maximum beam on water-line,

and such an expression is extremely useful for preliminarily estimating the size of stub planes required, as well as for many other reasons.

IN THE DRAWING OFFICE.

"ON ANGLES."

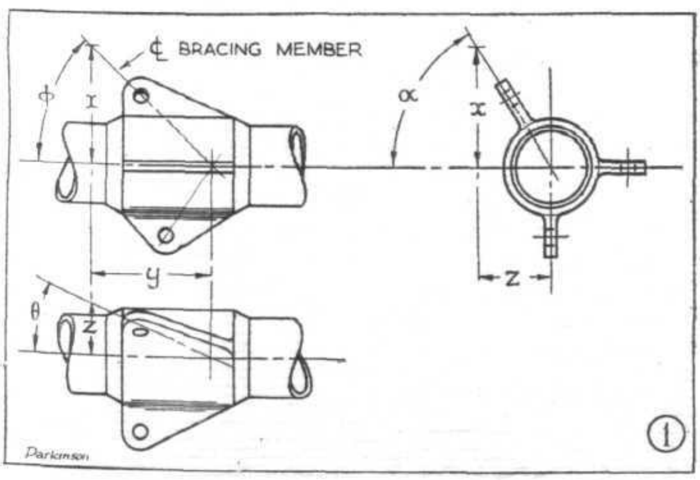
By H. PARKINSON, A.R.AE.S.I.

The determination of compound angles, in personal experience, usually entails careful geometrical layout and checking before one feels happy enough to issue the drawings involved for the purposes of manufacture.

Methods of checking by calculation are offered by use of the simple trigonometrical formulæ enumerated herein, together with every-day examples illustrating their use.

The pulley bracket example may be of interest to those who are already conversant with the basic formulæ.

Case 1.

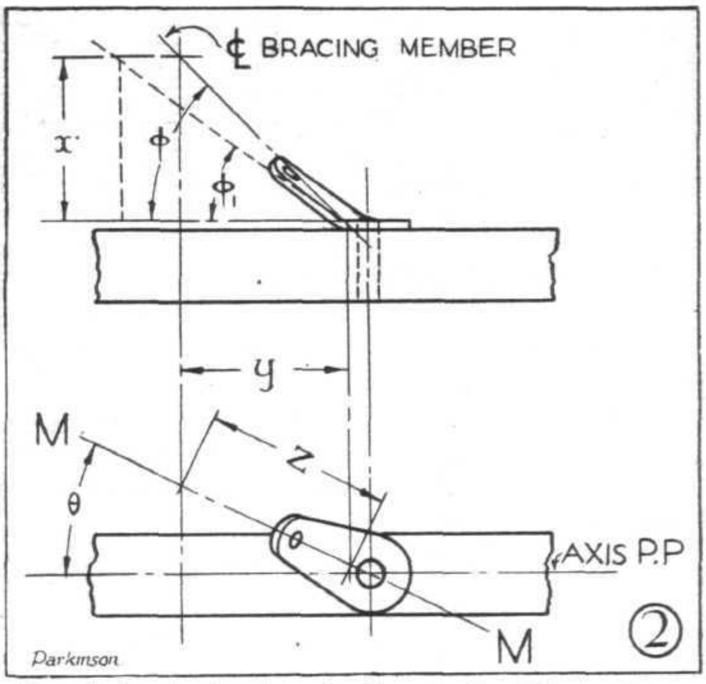


Required : α *i.e.*, true machining angle of lug. Known apparent angles : θ and ϕ.

$$\frac{x}{y} = \tan\phi \;:\; \frac{z}{y} = \tan\theta \;:\; \frac{x}{z} = \tan\alpha$$

$$\operatorname{Tan}\alpha = \frac{y\tan\phi}{y\tan\theta} = \frac{\tan\phi}{\tan\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Case 2.



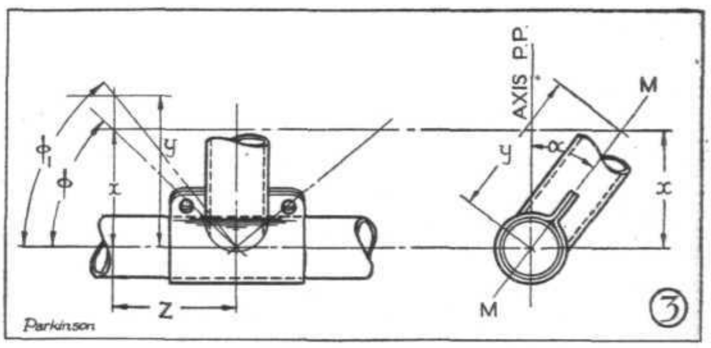
Required : ϕ_1 *i.e.*, true bend-up angle of lug. Known apparent angles : θ and ϕ.

In plan line MM is rotated through angle θ to coincide with axis P P and angle ϕ, in elevation, corrected to ϕ_1, *i.e.*, true bend angle of lug.

$$\frac{x}{y} = \tan\phi \;:\; \frac{y}{z} = \cos\theta \;:\; \frac{x}{z} = \tan\phi_1$$

$$\operatorname{Tan}\phi_1 = \frac{y\tan\phi}{\dfrac{y}{\cos\theta}} = \tan\phi\cos\theta \quad \ldots\ldots\ldots\ldots(2)$$

Case 3.



Required : ϕ_1, *i.e.*, true angle of bracing member in plane of lug.

Known apparent angles : α and ϕ

In end elevation the line M M is rotated through angle α to coincide with axis P P and the apparent angle ϕ, in side elevation, is corrected to the true angle ϕ_1

$$\frac{x}{y} = \cos\alpha \;:\; \frac{x}{z} = \tan\phi \;:\; \frac{y}{z} = \tan\phi_1$$

$$\operatorname{Tan}\phi_1 = \frac{\dfrac{x}{\cos\alpha}}{\dfrac{x}{\tan\phi}} = \frac{\tan\phi}{\cos\alpha} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

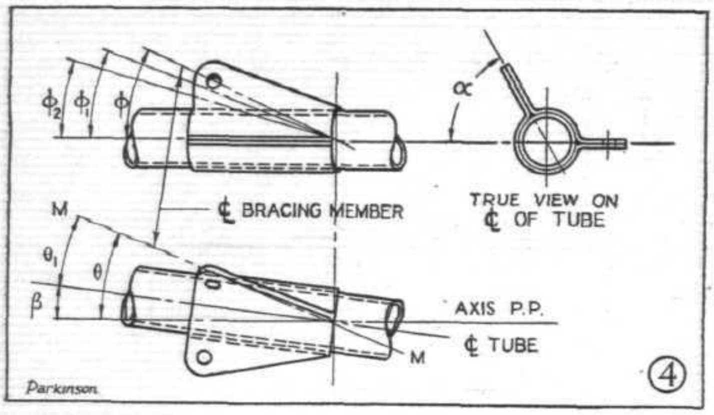
Case 4.—*Compound example of Case* 1.

In plane C/L of tube is rotated through angle β to coincide with axis P P, and α plotted in end elevation from apparent angles θ_1 and ϕ_1.

In obtaining a mathematical solution the following procedure is adopted :—

(1) In plan, rotate line M M through angle θ to coincide with axis P P. In elevation angle ϕ becomes ϕ_2.

(2) In plan rotate line M M back through angle θ_1 to coincide with axis P P. In elevation angle ϕ_2 becomes ϕ_1.



$$\text{Tan } \phi_2 = \tan\phi\cos\theta \quad \ldots\ldots\ldots\ldots \text{ From (2)}$$

$$\text{Tan } \phi_1 = \frac{\tan\phi_2}{\cos\theta_1} \quad \ldots\ldots\ldots\ldots \text{ From (3)}$$

$$\text{Tan } \phi_1 = \frac{\tan\phi\cos\theta}{\cos\theta_1} \quad \ldots\ldots\ldots\ldots (4)$$

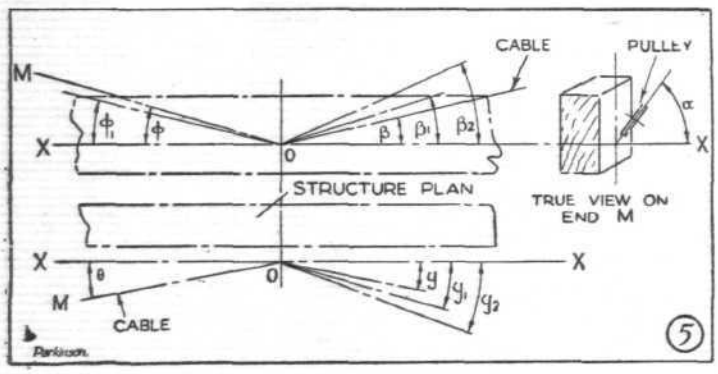
$$\text{Tan } \alpha = \frac{\tan\phi_1}{\tan\theta_1} \quad \ldots\ldots\ldots\ldots \text{ From (1)}$$

$$\text{Tan } \alpha = \frac{\tan\phi\cos\theta}{\cos\theta_1\tan\theta_1} = \frac{\tan\phi\cos\theta}{\sin\theta_1} \quad \ldots\ldots\ldots\ldots (5)$$

Case 5.

In designing a pulley bracket which involves compound angles, the problem is to find the true plane of the pulley relative to an arbitrarily chosen portion of the aircraft structure.

The methods available are varied; this example being that of obtaining a true view on one leg of the cable and then plotting the true angle of the pulley relative to that part of the structure previously chosen as a datum.



Known apparent angles from layout θ, ϕ, β, γ.
Required: α and relative position of structure.

(1) In plan rotate M O through angle θ into axis X X
γ becomes γ_1
ϕ ,, ϕ_1
β ,, β_1

(2) In elevation rotate M O through angle ϕ_1 into axis X X
β_1 becomes β_2
γ_1 ,, γ_2

We now plot α and relative position of structure, M O being in the plane of the paper in both plan and side elevation.

By calculation:

(*a*) $\tan\phi_1 = \tan\phi\cos\theta$ .... From (2)

(*b*) $\gamma_1 = \gamma + \theta$

(*c*) $\tan\beta_1 = \dfrac{\tan\beta\cos\gamma}{\cos\gamma_1}$ .... From (4)

(*d*) $\beta_2 = \beta_1 + \phi_1$

(*e*) $\tan\gamma_2 = \dfrac{\tan\gamma_1\cos\beta_1}{\cos\beta_2}$ .... From (4)

(*f*) $\tan\alpha = \dfrac{\tan\beta_2}{\tan\gamma_2}$ .... From (1)

Line M O now coincides with axis X X in both plan and elevation and it is obvious that structure has turned through θ clockwise in plan and ϕ_1 anti-clockwise in elevation.

This data may now be plotted for layout of bracket.

The following calculations for a wooden mock-up illustrate the practical application of the basic formulæ derived herein.

$$\phi = 10^\circ : \beta = 10^\circ : \theta = 5^\circ : \gamma = 25^\circ$$

$$\text{Tan } \phi_1 = \tan 10^\circ \cos 5^\circ = 0{\cdot}176 : \phi_1 = 10^\circ$$

$$\gamma_1 = 25^\circ + 5^\circ = 30^\circ : \gamma_1 = 30^\circ$$

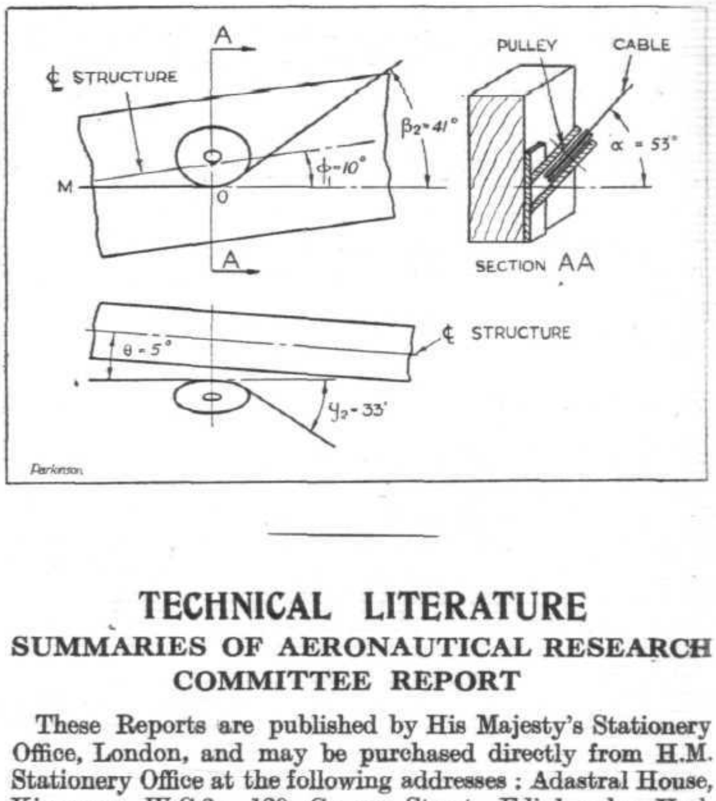
$$\text{Tan } \beta_1 = \frac{\tan 30^\circ \cos 25^\circ}{\cos 30^\circ} = 0{\cdot}604 : \beta_1 = 31^\circ$$

$$\beta_2 = 31^\circ + 10^\circ = 41^\circ : \beta_2 = 41^\circ$$

$$\text{Tan } \gamma_2 = \frac{\tan 30^\circ \cos 31^\circ}{\cos 41^\circ} = 0{\cdot}655 : \gamma_2 = 33^\circ$$

$$\text{Tan } \alpha = \frac{\tan 41^\circ}{\tan 33^\circ} = 1{\cdot}34 \quad \alpha = 53^\circ$$

This data is now plotted and the required bracket drawn to suit. The form of any individual bracket, of course, depends upon the local characteristics of the available structure.



TECHNICAL LITERATURE

SUMMARIES OF AERONAUTICAL RESEARCH COMMITTEE REPORT

These Reports are published by His Majesty's Stationery Office, London, and may be purchased directly from H.M. Stationery Office at the following addresses: Adastral House, Kingsway, W.C.2; 120, George Street, Edinburgh; York Street, Manchester; 1, St. Andrew's Crescent, Cardiff; 15, Donegall Square West, Belfast; or through any bookseller.

THE FLUTTER OF AEROPLANE WINGS. By R. A. Frazer, B.A., B.Sc., and W. J. Duncan, B.Sc., A.M.I.Mech.E. R. & M. No. 1155. (Ae. 320). (218 pages and 60 diagrams.) August 1928. Price 12*s.* 6*d.*

In the report of the Accidents Investigation Sub-Committee* dealing with the subject of wing flutter a brief description is given of a number of aeroplane accidents, in each of which a peculiar feature was "rapid and unusually large movements of the wings." In view of a possible recurrence of similar accidents as the speeds of aeroplanes are increased, the Sub-Committee recommended that "the vibration of aeroplane structures should be thoroughly studied, both from the theoretical and experimental standpoints, so as to provide data from which designers can calculate and so avoid instability, if any suspicion arises that the experience is likely to be repeated."

Investigations undertaken in accordance with the foregoing recommendation soon showed that the problem is very much more complex than was anticipated. Research upon the subject has by no means reached finality, but certain definite conclusions regarding the avoidance of wing flutter have now been drawn. In view of the practical urgency of the question, it has been thought desirable to publish as a monograph an account of the theoretical and experimental work hitherto completed, together with a statement of provisional conclusions and practical recommendations.

* R. & M. 1041. Accidents to aeroplanes involving flutter of the wings. Report of the Accidents Investigation Sub-Committee.

A general outline of the conclusions reached and recommendations made on this subject has already been published as a separate issue† of the Reports and Memoranda series and is here reprinted in front of the general theoretical and experimental investigation now published for the first time.

The theoretical part of the volume deals with the equations of motion of the wing-aileron system, with stability criteria and critical flutter speeds and with a graphical treatment of binary flutter problems, involving only two degrees of freedom. In the experimental investigation the authors had to develop a special technique for the measurement of the derivatives on flexible wings, due to torsion and flexure of the wing itself and to aileron movement. The cases discussed are named torsional-aileron, flexural-aileron and flexural-torsional, which provide self-explanation titles. The agreement between the observed calculated critical speeds was found to be sufficiently good to warrant the conclusion that the theory given in this monograph is adequate for the discussion of the flutter of aeroplane wings, but its real value lies in its application to the discovery of methods for preventing flutter.

The third part of the monograph deals with various recommendations for prevention of each type of flutter. Cantilever monoplanes, stayed monoplanes and biplanes are separately discussed and the influences of elastic hysteresis of friction and of abnormal wing incidences are dealt with. The report concludes with a warning to designers of the close relation that exists between the physical and aerodynamic properties of an aeroplane wing which may lead to insufficient care being taken in taking precautions to prevent flutter.

The monograph has a number of appendices dealing with specialised matters, contains an annotated list of references and a list of the principal symbols used with their significance. An adequate Index for the whole volume is included.

† R. & M. 1177. A brief survey of Wing Flutter with an Abstract of Design Recommendations. R. A. Frazer and W. J. Duncan.

PRESSURE DISTRIBUTION OVER A YAWED AEROFOIL. By D. H. Williams, B.Sc., with an Appendix on ROLLING MOMENTS ON A YAWED AEROFOIL. By A. S. Batson, B.Sc. R. & M. No. 1203 (Ae. 364.). (23 pages and 20 diagrams.) October, 1928. Price 2*s*. 6*d*. net.

The variation of pressure distribution on a wing with yaw is of great importance, and the work on control for stress calculations. Hitherto all pressure observations over an aerofoil have been made with an aerofoil at 0° yaw, and there have been no data available for determining how the pressure distribution alters when the aerofoil is yawed. The experiments described in this report have been undertaken to supply this coefficient.

The pressure distribution over a R.A.F.15 aerofoil, aspect ratio 6, has been measured over a range of incidence from 0° to 40° by 4° steps, and from 0° to 30° yaw every 5°. Below the stall, the distribution varies little with yaw except at the wing tips. Above the stall, the leading wing tip is unstalled while the trailing wing tip is stalled. The resultant pressure near the leading wing tip increases to over $2 \cdot 5\ V^2\rho$ at 30° incidence and 30° yaw. This gives rise to very large rolling moments. For comparison with the results obtained by integration, the rolling moments have been measured on the same aerofoil over the same range of incidence and yaw. The agreement is good.

CONDITIONS FOR THE PREVENTION OF FLEXURAL-TORSIONAL FLUTTER OF AN ELASTIC WING. By R. A. Frazer, B.A., B.Sc., and W. J. Duncan, B.Sc., A.M.I.Mech.E. R. & M. No. 1217 (Ae. 376). (16 pages and 1 diagram.) December, 1928. Price 9*d*. net.

The theoretical discussion of wing flutter given in R. & M. 1155* is based on the assumption that the wing can be treated as "semi-rigid"—in the sense that the flexural and torsional displacements at any section are supposed to be determined by the corresponding displacements at the reference section (*e.g.*, the wing tip). The practical validity of the assumption is well supported by the good agreement obtained in comparisons between experimentally observed critical flutter speeds and those predicted by the "semi-rigid" theory.† Nevertheless, an analysis of the problem based on a direct application of elastic theory—if mathematically feasible—would be useful as affording an independent test of the conclusions already drawn from the simpler theory.

The oscillations of an elastic cantilever wing without aileron are studied mathematically in a paper by S. B. Gates,‡ but simple conditions for stability are not stated. In the present report a similar analysis is adopted, and a general method for the discussion of the stability is developed. Further, the treatment is extended to stayed wings of a certain type.

The paper provides strong support for the principal deductions regarding stability of the flexural-torsional motion of a wing, drawn in R. & M. 1155 from the "semi-rigid" theory. Important additional conclusions are that the earliest flexural-torsional flutter of a monoplane wing whose mass distribution is approximately uniform will occur in the "fundamental" mode, and that if flutter in the fundamental mode has been prevented, it will not occur in any higher mode.

* "The Flutter of Aeroplane Wings." By R. A. Frazer and W. J. Duncan. August, 1928.

† See R. & M. 1155, Chapter VII.

‡ "The Torsion-Flexure Oscillations of Two Connected Beams." S. B. Gates. "Phil. Mag.," January, 1928.

THE FLUTTER OF AEROPANE TAILS. By R. A. Fraser, B.A., B.Sc., and W. J. Duncan, B.Sc., A.M.I.Mech.E. R. & M. No. 1237 (Ae. 392). (27 pages and 6 diagrams). January, 1930. Price 1*s*. 6*d*. net.

In R. & M. 276* an analysis is given of the oscillations of the tail of an aeroplane in flight, the degrees of freedom assumed for the dynamical system being angular movement of the elevators about their hinges, and torsion of the fuselage. Amongst the measures suggested in that report for the elimination of flutter are :—(1) connection of the two elevators by a tube stiff in torsion ; (2) Introduction of artificial elevator damping.

The oscillations of a tailplane in flexure and torsion are examined by an approximate theory in Report No. 285† of the National Advisory Committee for Aeronautics. Location of the centre of mass in, or forward, of the main supporting spar with the centre of pressure aft of this member is recommended—or, alternatively, an increase of structural rigidity.

A recent paper by Mr. H. Bolas‡ deals with the static distortion of elastic tailplanes, and provides a basis for the calculation of the flexural-torsional divergence speed.

In the present report the problem of tail flutter is treated by methods strictly analogous to those used for wing flutter in R. & M. 1155.§ The underlying principle is the substitution of semi-rigid counterparts for such portions of the moving system as are likely to distort appreciably under the acting loads. For simplicity, only the tailplane and the fin are dealt with in this way, and elevator and rudders are treated as rigid. As further limitation which is imposed is that the only important motion of the fuselage is torsional.

Part I of the present report gives a general survey of the dynamical theory of tail flutter and divergence. The motions discussed involve twist of the fuselage, flapping of the elevators and rudder, and distortion of the tailplane and fin. Criteria for stability are examined, and simple sufficient conditions for the avoidance of flutter are deduced.

Part II gives an account of some wind tunnel experiments, the results of which are in good accord with the theoretical conclusions. The results of the tests are in general accord with the theoretical conclusions of Part I. Anti-symmetrical flutters of the following types were demonstrated :—

(1) Binary fuselage-elevator flutter.
(2) Binary fuselage-rudder flutter.
(3) Ternary fuselage-elevator-rudder flutter.

The experiments indicate that, at least for the case where the tailplane and fin are very stiff, rudder flutter can be avoided by suitable mass loading or by adoption of a rudder symmetrically disposed about the axis of torsion of the fuselage : further, that flutter of the elevators can be eliminated by the provision of a very stiff direct connection between the elevators, or by mass loading. A high torsional stiffness of the fuselage does not appear to be particularly advantageous. Lastly, very close approach to aerodynamical balance of the control surfaces may be dangerous.

* R. & M. 276. "Torsional Vibrations on the Tail of an Aeroplane," Part 2.—L. Bairstow and A. Fage, 1916.

† "A Study of Wing Flutter."—A. F. Zahm and R. M. Bear. N.A.C.A. Report No. 285, 1928. (Revise of earlier report dated 1926).

‡ "Tail Flutter—A New Theory."—H. Bolas. "Aircraft Engineering," March, 1929.

§ R. & M. 1155. "The Flutter of Aeroplane Wings."—R. A. Frazer and W. J. Duncan. August, 1928.

PART I.—CHARACTERISTICS AND ENGINE PERFORMANCE OF GASEOUS FUELS OBTAINED FROM OIL. PART II.—ENGINE PERFORMANCE FROM KEROSENE/OIL GAS MIXTURES. By Sqdn.-Ldr. Helmore, M.Sc. Experiments carried out for the Aeronautical Research Committee at the Cambridge University Engineering Laboratory. R. & M. No. 1265 (E. 33). (54 pages and 14 diagrams.) September, 1929. Price 3*s*. net.

With a view to obtaining engine performance data on gaseous fuels suitable for use in airships, an examination was made of various gases evolved by the destructive distillation of oil. This particular source of gas fuel was chosen both on account of its low cost of production (approximately the same cost for heat value as petrol), and also because the density of oil gas approximates closely to that of air and can be varied within limits as desired during manufacture.

The subjects of enquiry included the methods of making gas from oil, the yield of gas obtainable from oil at various temperatures of distillation, various methods of determining gas densities relative to air, and the limits within which this property may be varied. Single-cylinder engine tests were carried out on a Ricardo E.35 variable compression engine on "light" oil gases (densities 0·723 and 0·774) and on "heavy" oil gas (density 1·05). A Rolls Royce "Eagle VIII" 350 h.p. aero. engine was converted to 7 : 1 compression ratio and run on gas fuel.

"Light" oil gas (density 0·774 approx.) appears to be the most economical and efficient fuel of this series tested. It is not anticipated that an oil gas of density greater than 1·05 relative to air could be produced by this method without greatly increased cost and decreased stability. It has been found impossible to cause backfire into the fuel intake with this gas either by varying mixture strength or engine speed, the engine having been brought to a standstill by this means at either end of the mixture range. No sign of detonation or pre-ignition were observed even at 7 : 1 compression ratio.

Engine tests carried out with this light oil gas on a Rolls Royce 350 h.p. aero engine confirmed the experimental single-cylinder results, the absence of detonation and tendency to backfire being maintained. Very smooth running and improved distribution were observed, whilst easy starting and flexible control over the whole mixture range was found to result from the principle of gas carburation employed.

To examine the possibility of employing kerosene as an auxiliary fuel to oil gas in an internal-combustion engine of normal design, and with a view to the ultimate use of this combination of fuels in airship engines, the Ricardo E. 35 engine at Cambridge University was run on various proportions of kerosene and oil gas up to a compression ratio of 7 : 1. Tests at full-scale were also carried out on a Rolls Royce "Eagle VIII" aero engine (converted to 7 : 1 compression ratio) on kerosene/oil mixtures.

It appears that high efficiencies can be obtained from the combustion of a non-volatile fuel such as kerosene by means of a readily combustible gaseous fuel such as the oil gas used in the present instance. At the same time the tendency to detonate normally possessed by kerosene is largely negative. The tests carried out at full scale on the Rolls Royce "Eagle VIII" aero engine, which are probably the first of their kind attempted, were entirely satisfactory. No distribution difficulties were encountered, and it was found possible to employ a wider range of kerosene/oil gas ratios than on the Ricardo E. 35 engine without detonation. The fuel consumption at full power* on kerosene/oil gas mixtures averaged 0·455 lb. per b.h.p. hour, as against 0·52 lb. per b.h.p. hour obtained from the standard engine on petrol.

* This refers to the designed full power of the engine at 5 : 1 compression ratio.

REDUCTION OF DRAG OF RADIAL ENGINES BY THE ATTACHMENT OF RINGS OF AEROFOIL SECTION, INCLUDING INTERFERENCE EXPERIMENTS OF AN ALLIED NATURE, WITH SOME FURTHER APPLICATIONS. By H. C. H. Townend, B.Sc. R. & M. No. 1267 (Ae. 413). (77 pages and 27 diagrams.) July, 1929. Price 4*s*. net.

Some experiments are described in which large and frequently negative interference effects are found to be produced by certain objects of streamline

or aerofoil form upon the drag of (1) a model of airship form (U. 721); (2) model aeroplane bodies having radial engines in the nose; and (3) models in which turbulence is produced by grooves or sharp edges. The evidence provided by the tests shows that the effects produced in cases (2) and (3) are due not to shielding or fairing of the obstructions, but to the addition of small aerofoils to the models in such a way as to control the airflow in the neighbourhood of the obstructions, chiefly by governing its local direction.

The chief result of the experiments has been the development of a method of reducing the drag of radial engines, which consists in placing a ring of aerofoil section round the nose in front of the engine and partly overlapping it. The aerofoil section adopted for the ring may vary widely from a cambered plate to a thick symmetrical section such as could be used for an exhaust pipe or silencer.

The magnitude of the reduction obtained with a given ring increases with the number of cylinders in the engine, at least up to nine. With 14 cylinders in two rows the reduction is practically the same as with nine. In the best case tested (with nine cylinders) a reduction of drag was obtained equal to 60 per cent. of that of body and engine only (*i.e.*, $R/R_0 = 0 \cdot 40$).

Full-scale tests indicate that the cooling of the engine is usually unimpaired and in some cases improved. Considerable silencing may also be effected when the ring is used as an exhaust collector. The ceiling may be increased.

Full-scale tests are in hand at the R.A.E. in which measurements are to be made of the effect of two typical rings on the performance of a Bristol Bulldog aeroplane ("Jupiter" engine). The rings selected for test are the full-scale equivalents of Ring J and polygonal Ring P_3 shown in Fig. 25 of this report, with a slight modification to the angle between the chord and the body axis. The influence on the cooling of the engine is also to be measured.

EXPERIMENTS RELATING TO THE FLOW IN THE BOUNDARY LAYER OF AN AIRSHIP MODEL. By L. F. G. Simmons, M.A., A.R.C.Sc. R. & M. No. 1268 (Ae. 414). (7 pages and 6 diagrams.) April, 1929. Price 6*d*. net.

A knowledge of the relative areas exposed to laminar and to turbulent flow in the boundary layer has materially assisted towards a better understanding of the reason for the observed change in the skin friction coefficient of a thin plate at different speeds; and, largely through the theoretical work of Von Karman and Blasius, experimentally verified by Burgers and Zijnen, it is now possible to predict, within prescribed limits, depending on steadiness of the flow, the resistance of a thin plate with a good entry at any speed. More recently, Professor Jones has shown that the drag of good streamline forms, such as airships, must be influenced in a similar manner by the extent and nature of the flow in the boundary layer.

Consequently, the boundary layer on a good streamline shape was determined by explorations made at a number of sections with a total head tube. These extended chiefly over the rear half of the model airship, and also to some distance in the wake. In addition velocity measurements were made with a combined Pitot tube, in order to provide a check on the accuracy of the total head readings.

At a wind speed of 60 ft./sec. it was shown that from the tail to a section 30·8 forward, the velocity distribution obeyed a law similar in form to that deduced by Von Karman for turbulent flow. At a section 36·8 in. forward the distribution resembled that predicted by Blasius for laminar flow. It was, therefore, concluded that the transition occurred between these sections.

Confirmatory evidence is required on the position of transition points of bodies of different shapes. A special instrument is being prepared for this purpose, and it is hoped that this will be shortly available for work of this kind.

THE FULL SCALE DETERMINATION OF THE LATERAL RESISTANCE DERIVATIVES OF THE BRISTOL FIGHTER AEROPLANE. PART III. THE DETERMINATION OF THE RATE OF ROLL DERIVATIVES. By E. T. Jones, M.Eng. Presented by the Director of Scientific Research, Air Ministry. R. & M. No. 1270. (Ae. 416.) (7 pages and 7 diagrams.) July, 1929. Price 9*d*. net.

The lateral resistance derivatives of the Bristol fighter aeroplane have now been completely determined full scale at a wing incidence of 10°·0 approximately. The sideslip derivatives are given in R. & M. 987* and the rate of turn derivatives in R. & M. 1068†, while the rate of roll derivatives are given in the present report.

The method of determining L_p, full scale, by applying a known rolling moment in straight flight and measuring the subsequent motion in roll has been examined theoretically in R. & M. 938.‡ It is shown in that report that if the rolling motion of the aeroplane during the first-half second subsequent to the application of a known constant rolling moment is accurately recorded, then the value of L_p can be deduced with good accuracy, ignoring the rolling moments due to sideslip and rate of yaw in the disturbed motion. An instrument which will be referred to as a kymograph was designed especially for the experiments and the rolling and yawing motions of the aeroplane subsequent to dropping a heavy mass from one wing tip were recorded photographically.

The present experiments were made at angles of incidence of 10°·3 and 11·3°. The values of L_p referred to wind axes are $-$ 14,100 and $-$ 13,700 at angles of incidence of 10·3° and 11·3° respectively. The corresponding values of N_p are $-$ 1,350 and $-$ 2,800. The magnitude of L_p is within 2 per cent. of the model figure deduced from R. & M. 932,§ but the full scale value of N_p is much greater numerically than that given in R. & M. 932.

* The full-scale determination of the lateral resistance derivatives of a Bristol Fighter aeroplane. By H. M. Garner and S. B. Gates.

† The full-scale determination of the lateral resistance derivatives of a Bristol Fighter aeroplane. Part II. The determination of the rate of turn derivatives. By H. M. Garner.

‡ A theory of the full-scale determination of damping in roll. By S. B. Gates and H. M. Garner.

§ Experiments on a model of a Bristol Fighter (1/10 scale).
Section I.—Force and moment measurements at various angles of yaw. By Irving and Batson.
Section II.—Lateral derivatives by the forced oscillation method. By Frazer, Batson and Gadd.

EXPERIMENTS ON AN APE AEROPLANE FITTED WITH PILOT PLANES. By S. Scott-Hall, M.Sc., D.I.C. Presented by the Director of Scientific Research, Air Ministry. R. & M. No. 1273. (Ae. 419). (5 pages and 10 diagrams). May, 1929. Price 9*d*. net.

The pilot plane is an auxiliary aerofoil pivoted freely ahead of a wing, the upward rotation being limited by a stop. At high angles of incidence the pilot plane rotates upwards until it reaches the stop and then provides a leading edge slot with the well-known characteristics. At small angles of incidence it falls away from the stop and automatically sets itself for low drag. The purpose of the experiments was to determine the best maximum angle for the pilot planes on a R.A.F. 15 wing section fitted to an Ape aeroplane, as determined by the position of the stops limiting their upward rotation, and to determine the maximum lift obtainable with this setting.

The Armstrong Whitworth Ape 7754 was fitted with pilot planes along the whole of the leading edges of top and bottom planes. The outer pilot planes in front of, and inter-connected with the ailerons were maintained at a constant setting throughout the tests (40·5° maximum angle to the main wing chord with ailerons neutral). Measurements of maximum lift were made with the remaining pilot planes set at mean angles of 35·6°, 38·5°, 39·8°, 39·8°, 42·9° to the main wing chord and other measurements were made with these pilot planes removed.

The maximum lift coefficient obtained with the pilot plane set at 39·8° was 0·71. With the inner pilot planes removed but with those connected with the ailerons left in position, the maximum lift coefficient was 0·54.

STRESSES AND STRAINS IN AIRSCREWS WITH PARTICULAR REFERENCE TO TWIST. By R. McKinnon Wood, O.B.E., M.A., and W. G. A. Perring, R.N.C. Presented by the Director of Scientific Research, Air Ministry. R. & M. No. 1274 (Ae. 420). (14 pages and 4 diagrams.) April, 1929. Price 9*d*. net.

In order to calculate correctly the performance of an airscrew in process of design or for purposes of research, knowledge of the extent to which the blades twist under running loads is required.

A theoretical analysis has been made assuming solid homogeneous isotropic blades, and fairly comprehensive equations have been deduced. Approximations have been indicated and a summary given of a simplified approximate calculation for drawing office use; this should be adequate for the commonest forms of airscrew. Hollow blades have also been discussed. Expressions for bending moments are included.

A short length of the blade may be treated as a short length of a cylinder under end load, bending and twisting moments, provided that the twisting moment is augmented by a quantity depending on the end load and rate of change of blade angle.

The calculation of centrifugal twisting moment is complicated, but if the centre line of the blade is straight and intersects the axis of rotation at right angles, this moment is closely represented by a single term proportional to the greater principal moment of inertia of sections and to the sine of twice the blade angle.

The analysis is applicable to hollow blades with certain alterations.

THE EFFECT OF SPAN ON AIRCRAFT PERFORMANCE. By W. G. Jennings, B.Sc., in collaboration with Messrs. Boulton and Paul, Ltd. Presented by the Director of Scientific Research, Air Ministry. R. & M. No. 1276 (Ae. 422). (17 pages and 11 diagrams.) May, 1929. Price 1*s*. net.

The performance of three aeroplanes of the same type of about 9,000 lb. total weight and incorporating wings with spans of 60 ft., 70 ft. and 80 ft., respectively, have been calculated and the results compared. The estimates are based upon a full design of the wing structures.

From the results of the performance calculations it would appear that at low altitudes little change in performance is to be expected by increasing the span from 60 ft. to 80 ft. for this type of aircraft. At high altitudes, however, the larger span improves the performance appreciably and a marked increase in absolute ceiling is obtained. At all heights the maximum range of the larger span is considerably greater than that of the smaller span aeroplane. The calculations also indicate that the optimum span for performance at high altitudes would be appreciably greater than 80 ft. for this type of aircraft. A relatively poor performance at low altitudes would, of course, accompany such a large increase of span.

The above estimate of the effect of span on performance is based on the assumption that the extra to wing structures of three aeroplanes designed to the same specification and incorporating the three given sets of wings will be in such a form that they will have no influence on the relative performances. Also the assumptions that enter into the method of performance prediction from design data only (*e.g.*, interference effects, etc.) may modify to some extent the above conclusions.

It is considered, however, that the above effect on performance is an indication of what may be expected when the span of an aircraft of this type is varied, and this is substantiated by detailed consideration of a number of matters dealt with in appendices.

TESTS UNDER CONDITIONS OF INFINITE ASPECT RATIO OF FOUR AEROFOILS IN A HIGH-SPEED WIND CHANNEL. By T. E. Stanton, F.R.S. R. & M. No. 1279 (Ae. 425). (4 pages and 2 diagrams.) October, 1929. Price 4*d*. net.

Tests have been made at a speed of half the velocity of sound at angle of incidence ranging from 0 to 6 degrees on the following aerofoils:—(1) R.A.F. 27, (2) R.A.F. 27 with modified nose, (3) R.A.F. 30, (4) R.A.F. 30 with modified nose. A set of tests was also made on R.A.F. 30 at $u/a = 0 \cdot 35$.

Comparison of the results with those obtained from models of aspect ratio 6 : 1 tested in a low-speed wind channel and corrected for infinite aspect ratio, given in R. & M. 1072,* show a close agreement as regards lift, but marked disagreement in drag. This disagreement extends to the case of the lower speed tests at $u/a = 0 \cdot 35$.

* R. & M. 1072. The Characteristics of Certain Aerofoil Sections for Infinite Aspect Ratio. By A. S. Hartshorn.

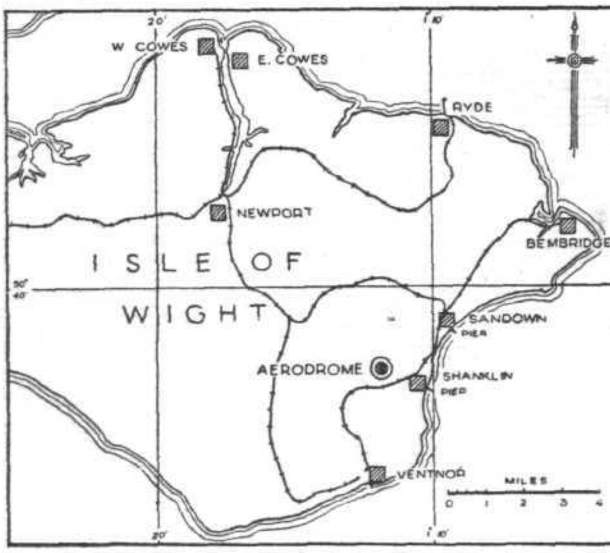
PRIVATE FLYING AND CLUB NEWS

THE ISLE OF WIGHT FLYING CLUB cordially invite all members of Light 'Plane Clubs, private owners, and others concerned with aviation, to attend at their Air Pageant, to be held at Shanklin Aerodrome, on Thursday, June 12, at 2.15 p.m., on the occasion of the official opening of the Club by Air Vice-Marshal Sir Sefton Brancker. A very attractive programme has been arranged, and a number of well-known pilots have promised to attend. Members of any flying clubs, and the personnel of visiting aircraft will not pay for admission.

Luncheons and teas will be obtainable on Aerodrome.

The programme will consist of a grand fly-past of all types of machines, a parachute drop by John Tranum, an aerobatic competition (open to all pilots), a balloon bursting competition ("A" pilots only), an exhibition flight by winner of aerobatics competition, a take-off competition (open to all pilots), and bombing the car ("A" pilots only).

Joy-riding will be carried out throughout the meeting by Wight Aviation, Ltd. The Aerodrome is exceptionally good for a Club and our small map will serve to show its approximate position.



A partial map of the Isle of Wight showing the aerodrome.

THE PETERBOROUGH FLYING MEETING. Peterborough's first flying meeting on Saturday, May 24, at Mr. K. Whittome's private aerodrome at Horsey Toll, was a great success, due to the efforts of Mr. Whittome and the Flying Committee of the Northamptonshire Aero Club.

A crowd of about 6,000 watched the flying from an adjoining field, which being slightly higher than the aerodrome was a natural grandstand.

The programme was opened by Flt.-Lt. Rose, with one of his perfect exhibitions of crazy flying, and then there was some effective formation flying by Flt.-Lt. Rose, Mr. P. Grey, and Mr. Runtz-Rees.

The race between the club private owners produced some exciting moments.

Mr. G. Linnell got away first and led for nearly two laps when he was overtaken by Mr. S. P. Tyzack. During the last lap the crowd got wildly excited, and great jubilation was felt when Mr. K. Whittome (who had been handicapped heavily) passed the others right on the winning post.

Mr. Palmer, the club instructor, flew over from Northampton and gave an excellent display of aerobatics in G.A.A.I.E.

Mr. S. A. Thorne showed that a Desoutter, besides being as comfortable and luxurious as a saloon car, can also be stunted, with ease, *by Mr. Thorne*.

The little blue Klemm was shown to advantage by Mr. Rogers.

Several pilots tried balloon-bursting, Flt.-Lt. Rose being the most skilful. As usual at these meetings a small car drove out to be bombed. The bombing 'planes must have been more than usually accurate, for one of the passengers was knocked out of the car more than once during the performance!

During the afternoon there was joy-riding by the Brooklands School of Flying. Some idea of the keenness of the people to fly may be gathered from the fact that Mr. Davis himself took over 150 people for flights, while Mr. Palmer also did some business with the club Moth—GAAIE. Visiting pilots numbered nearly 20, and included amongst them: The Hon. Loel Guinness, in a Bluebird, and Mr. Fitzwilliam, the prospective Conservative candidate for Peterborough. Mr. Fitzwilliam, whose family has been connected with Peterborough and the Fitzwilliam hounds for many years, immediately became a member of the Northants Aero Club.

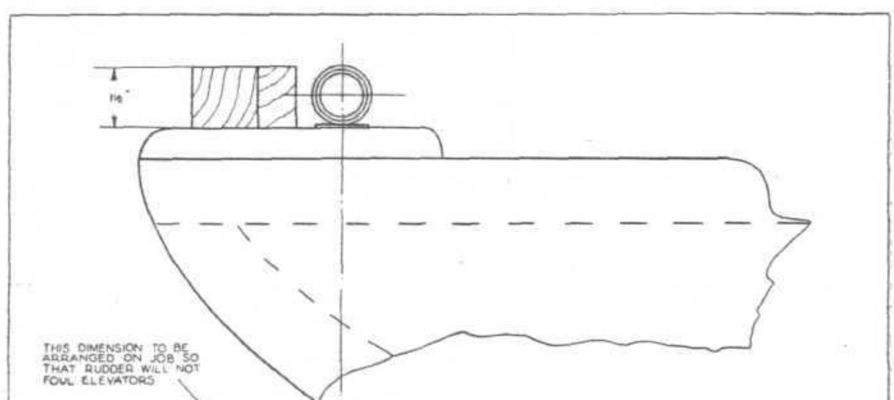
Mrs. Whittome, Mr. K. Whittome's mother, provided a delightful lunch for all the visiting pilots, and also for all the members who came over from Northampton to help.

It is hoped to arrange another meeting in Peterborough later on, at which all the pilots who were there on Saturday, and many others, will be welcome.

In the meantime, Mr. Whittome will always be pleased to see visitors who call at Horsey Toll Aerodrome. The aerodrome is on the east side of Peterborough—on the Whittlesea Road, and is fully licensed for joy-riding.

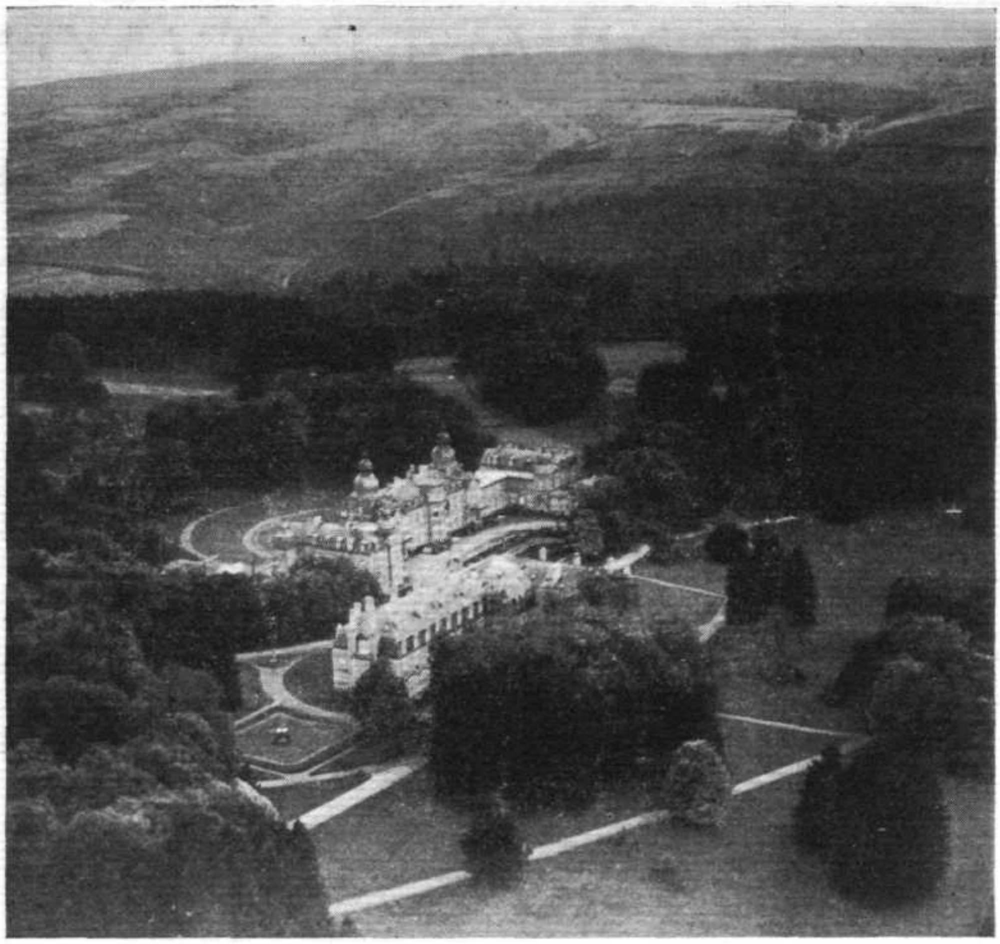
GLIDING CERTIFICATES. The Royal Aero Club has issued the following Gliding Certificates:—

No. 1	C. H. Lowe-Wylde ..	Certificate "A"
No. 2	C. H. Latimer Needham	Certificate "A" and "B"
No. 3	Marcus D. Manton ..	Certificate "A"



A further detail drawing for the Dickson Glider which completes the series for the controls.

CHATEAU d'ARDENNES



ON Saturday and Sunday, May 17 and 18, the Chateau d'Ardennes, near Dinant, was the scene of a very successful "Aerial week-end," which was organised by the Brussels Aero Club.

The Chateau has a notable, though somewhat tragic, history. It was, in the first place, the home of Leopold, the grandfather of the present king, who at one time owned the territory now known as the Belgian Congo, in Africa. He took a great interest in this African property at first, but as he gradually became tired of it, he relinquished it to the nation, and thus the Belgian Congo came to be built up.

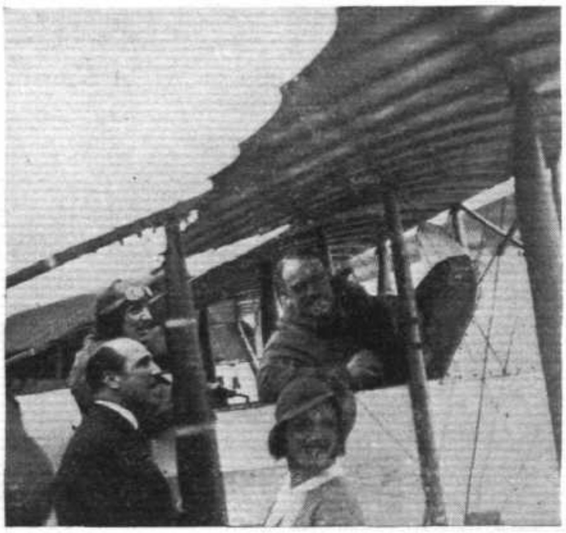
After the death of his son he turned against his wife and friends, and eventually refused to live in this Chateau. Since then it has gone through many vicissitudes, and is now run as one of the Les Grands Hotels Europèens.

The aerodrome, which is rather under a mile from the chateau in an E.S.E. direction, is somewhat tricky, and even some of the well-experienced visiting pilots were glad of the cordon of helpers who were drawn up ready to help them on landing, and prevent them running into the far hedges.

The party of about 20 machines, of which a large percentage was from England, gathered at Brussels on Saturday morning, where they were entertained to lunch by the Aero Club, after which they left for the Chateau. In the evening there was dinner, with a dance afterwards. The following morning was spent in seeing the Chateau and its beautiful grounds, and after lunch the visitors departed.

Among those who attended from this country were Lady Bailey, Mrs. Cleaver, Miss Slade, Miss Spooner, and Messrs. Norman, Muntz, McClure, Wills, and Cubitt.

Quite a wide range of machines was to be seen from a Belgian Handley-Page, down through St. Huberts, Moths, Avians and Bluebirds, to an old Caudron, of about the year 1914. Our photographs show a view of the Chateau and of the aerodrome from the air, while in the upper small picture may be seen the old Caudron, and below, on the left, are Mr. and Mrs. Ivor McClure, who arrived in their newly-acquired Moth G-AAAA, and on the right, Mr. and Mrs. Norman are receiving a glass of "Vin d'honneur" from the officials on their arrival.



CHATEAU d'ARDENNES: An aerial view of the aerodrome.

THE BRISTOL AIR PAGEANT, Saturday, May 31.—The opening ceremony by H.R.H. Prince George will take place on the roof of the Clubhouse.

The Continental Air Rallye is due at Bristol, midday, on Friday, May 30, as also are entrants in competitive events.

On Saturday, May 31, flying will start at 10 a.m. with heats of races, joy-riding, aerobatic displays, &c., until 2.30 p.m., when all flying will cease until the arrival of H.R.H. Prince George at 3 p.m., when the opening ceremony will take place and the Pageant proper commence.

Extensive arrangements have been made to ensure the success of the Pageant, and the publicity work so ably carried out under the direction of Mr. R. Ashley Hall should bring a very large audience to appreciate these arrangements.

NATIONAL FLYING SERVICES, LTD., announce that for the future no landing fees will be charged for privately-owned aircraft landing at the London Air Park, Hanworth, and visitors arriving by air will be made honorary members of the Hanworth Club for the day.

The Company state that it is impossible to offer similar facilities at municipal aerodromes under their control in the provinces, owing to the fact that the municipal authorities demand payment for landings, except by members of the N.F.S. flying clubs.

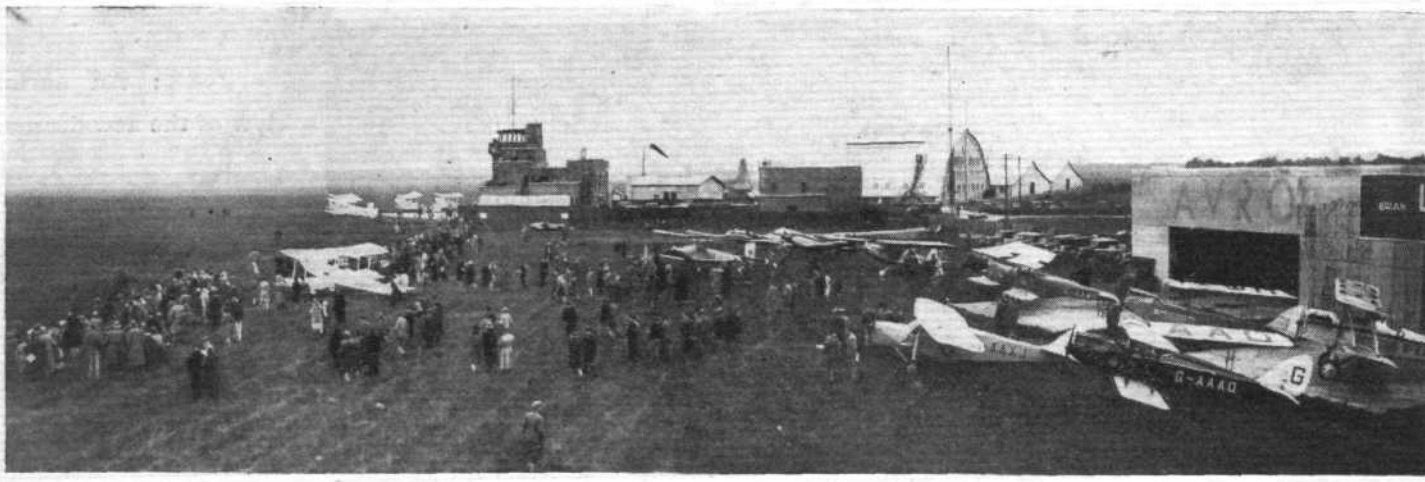
A SHELL MOTH IN AUSTRALIA: F/O. Owen hands over the log books of the Shell Co.'s new Moth to the General Manager, Mr. O. Darch.

ENTERPRISE! Auto-Auctions, Ltd., the Bluebird agents, have fitted this Machine with the new Goodyear Air Wheels.

HESTON was the scene of considerable enterprise on the part of Auto-Auctions, Ltd., last Sunday, May 25, when they invited the Junior Car Club and many others to come and be initiated into the pleasures of flying.

Some 1,000 cars were present, and many more spectators; and everyone enjoyed their initiation. The idea of the gathering was not so much an air meeting as a meeting of those who though keen on aircraft, had not yet had the opportunity of learning anything about them. Consequently all those who arrived at Heston were dead keen without being even a little bit blasé.

Many well-known pilots were there to show how machines can be handled, and these included Mr. Holman, the Sales Manager of Cirrus Engines, Ltd., who arrived in his Hermes-Avian, Flight-Lieut. Stainforth in the Junkers Junior belonging to Trost Bros., of Croydon, Mr. Blake in the Blackburn Lincock, and Capt. Broad in a production D.H. Puss-Moth. All put up very fine exhibitions.



Mr. Sidney St. Barbe emulated a naval action in the way he distributed smoke around the horizon from his S.E.5a, and Mr. Dudley Watt showed that flying slowly can be safe on the right machine. The weather was very bad and the visibility poor, but in spite of this a considerable amount of flying was done and the Argosy which Auto-Auctions had chartered to give free joy rides put in a lot of hard work. Several Bluebirds were to be seen flying, and one in particular, as our photograph shows, was fitted with the new Goodyear air-wheels. The Breda also put up an excellent show, and F/O. Store certainly seems to know just how to get the best out of this machine.

Sqdn.-Ldr. Ridley, who is responsible for the energetic way in which Auto-Auctions have taken up the flying side, was there, and both Messrs. Norman and Muntz, the directors of Airwork, Ltd., were as usual doing their best to help everybody. Auto-Auctions, Ltd., of course, deal in cars as well as aircraft, and one of their lines is the Lea-Francis, a supercharged model of which was used for the "bombing the car" item. The super-charger, however, worked so well that the pilot of the aircraft was unable to catch the car.

FOR CONTINENTAL TOURISTS. Those contemplating touring will be interested in the following letter received from Etablissements Geo. Nash, Ateliers et Magasins, 82-84, Rue du Lillier, Abbeville (Somme).

"As the summer is now approaching, many private owners of Moths will be visiting the Continent, and it will be of interest to them to know something of the facilities afforded at Abbeville.

"Being the recognised representative for the Imperial Airways and Air Union, and catering for the Farman, K.L.M., Caudron, Military Service, Navigation Aerienne, etc., I always have a stock of special petrol and oils at the Abbeville Aerodrome. In a short time I shall have an electrically-operated pump for refilling large planes, the plans for this installation have been passed by the French Air Ministry, work will be put in hand practically at once.

"The Abbeville Aerodrome is about half-way distance between Paris and London and an ideal landing ground, and within 10 minutes of the town and station on the main line for Paris and Boulogne. If by any chance any of your plane owners or pilots are flying this way and are forced down by contrary weather, every facility for transport and hotel accommodation is in operation and special prices at the best hotel have been arranged by me.

"I have special breakdown cars and all material necessary and a garage at your disposal if required, for repairs to aero motors, if conditions are too bad to carry out the work at the Aerodrome.

"(Signed) Geo. Nash."

CINQUE PORTS FLYING CLUB.—Ashwell-Cooke Challenge Cup Competition. The next competition will be held on Sunday next, June 1, at 15.30 hr., and we hope that private owners returning from the Bristol Air Pageant on the previous day will make a detour, via Lympne, in order to compete on their way home to London.

COMMERCIAL AVIATION! At top and bottom of this page we give panoramic views of Heston last Sunday, while in the centre the Lea-Francis car is "preening" itself on having avoided many "bombs."
(Flight *Photos.*)

AIR TRANSPORT

THE INTERNATIONAL CONFERENCE ON AVIATION LIGHTING IN BERLIN

By G. H. WILSON, B.Sc. (Eng.), A.M.I.E.E.

THE development of night flying is as inevitable as night transport by road, rail or sea has been. Already night air mail services have been established in this and other countries, and it is not too soon to consider the all-important subject of lighting for night flying.

The problems encountered are similar to those met with in maritime work, although probably somewhat more intricate. In the first case, aircraft must carry navigation lights, for obvious reasons of safety, and in the second, the aerodromes at which a pilot wishes to land must be clearly discernible and facilities must be available which will permit safe landings or ascents to be made. A desirable addition to these essentials is the beaconing of recognised airways, so that a pilot may check his course by visual indications.

In Europe, airways must inevitably become international in character, and it is highly desirable that the methods of aviation lighting be similar in all countries. In this way, the confusion and danger which would arise from differing national codes of lighting can be avoided.

With these objects in view, sectional meetings of the International Commission on Illumination, a body which endeavours to study all matters bearing on illumination, were held in Berlin on April 28, 29 and 30.

About 90 delegates attended the sessions, representing the National Illumination Committees of the following countries: Austria, Czecho-Slovakia, Denmark, France, Germany, Great Britain, Holland, Hungary, Japan, Norway, Poland, Sweden, Switzerland, and the United States. The British delegation, which numbered 10, was constituted as follows:—

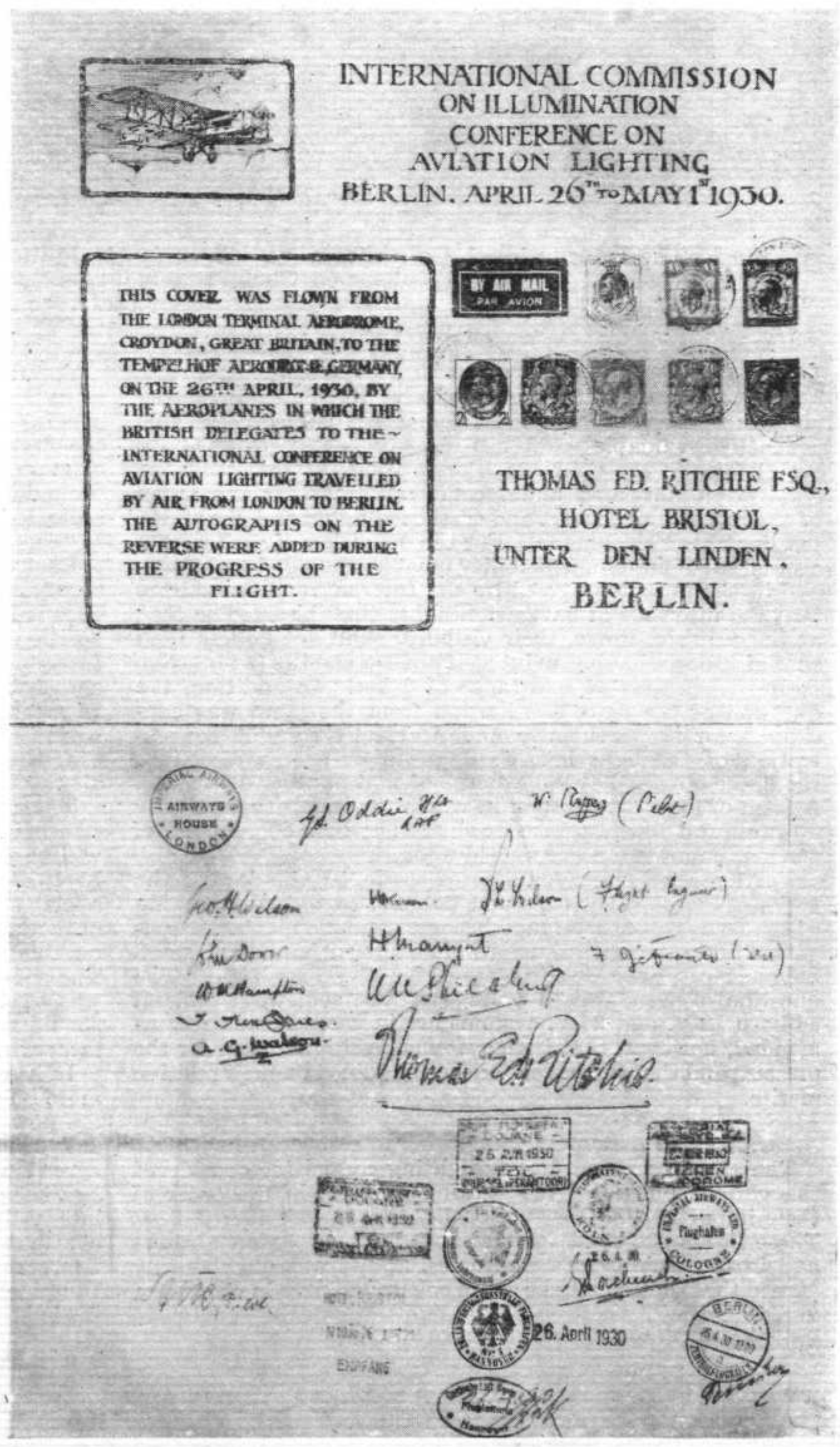
Major R. H. S. Mealing (Chairman and Leader), Air Ministry; Mr. H. W. Green, Capt. T. Kerr Jones, Flt.-Lieut. E. S. Oddie, Air Ministry; Major J. W. Buckley, Metropolitan-Vickers Electric Co., Ltd.; Mr. H. Marryat, Neon Lights (1928), Ltd.; Dr. W. M. Hampton, Chance Brothers, Ltd.; Mr. T. E. Ritchie, General Electric Co., Ltd.; Mr. A. G. Watson, Gas Accumulator Co.; Mr. G. H. Wilson, G.E.C. Research Laboratories (Secretary).

In addition, Mr. C. C. Paterson, President of the Commission, and Dr. W. S. Stiles, General Secretary, attended the meetings in their official capacities.

Eight of the delegation flew from Croydon to Berlin on April 26. The "City of Liverpool" (Imperial Airways) took them to Brussels and Cologne, when a Luft Hansa machine completed the journey via Hannover to Berlin.

The meetings, which were held at the Technische Hochschule, Charlottenburg, began on Monday, April 28, with a session to settle details of procedure. This was followed by the first technical session, at which the following matters were considered:—

For the purposes of International correspondence it is important to have equivalent technical terms in various



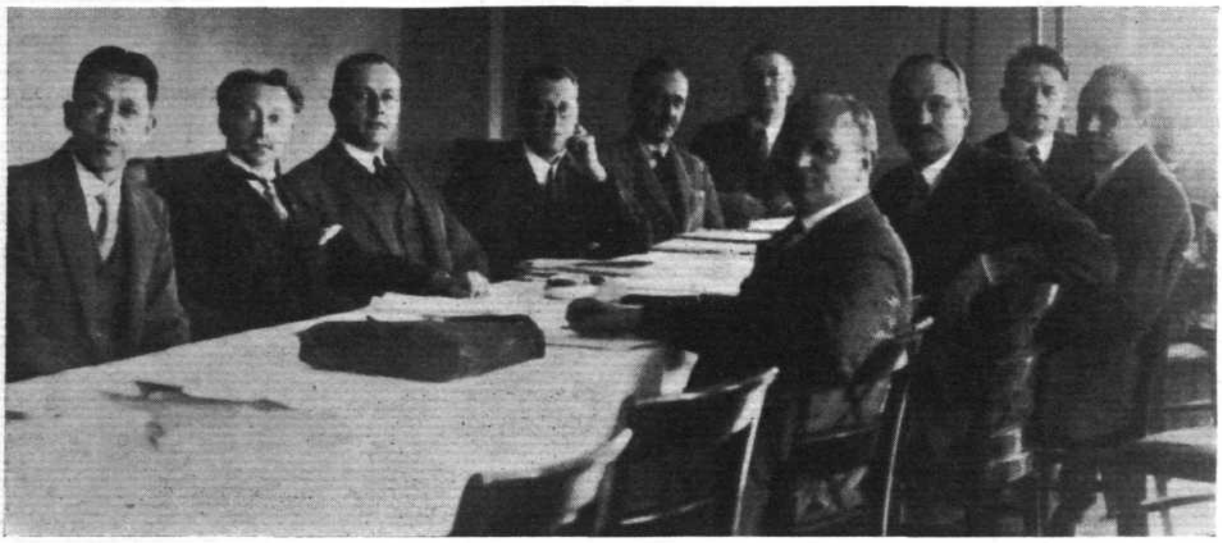
AN INTERESTING AIR MAIL COVER: This was carried by the Imperial Airways airliner "City of Liverpool" (Croydon-Brussels), and the Luft Hansa machine (Brussels-Berlin), which conveyed the British Delegates of the First International Conference on Aviation Lighting to Berlin on April 26. The reverse bears the autographs of the delegates and the pilots, various official cachets of the points of call en route. It is postmarked Croydon Aerodrome, 26th April/30, and is backstamped Berlin, Zentralflughafen, 26-4-30. 19—20.

languages, and one of the first tasks of the conference in Berlin was to find French and German equivalents of such terms as airway beacon, location beacon, obstruction lights, boundary lights, landing floodlights, landing direction lights, illuminated wind indicator, navigation lights, &c.

This having been accomplished, the delegates from the various countries were invited to report on the present position of aviation lighting in their respective countries, and from the data given, endeavours were made to reach international agreement on the requirements of the various lights.

Boundary lights are used to show the safe manœuvring limits of an aerodrome and at the present time national views are somewhat divergent on the best colour for these lights. It was only possible to agree that the recommended colours for the boundary lights should be *red*, *orange* or a *combination of red and white*. Further study, it is hoped, will show the superiority of one particular colour and at a later date agreement may be possible on that colour.

For the purposes of aerodrome landing lighting two methods appear to be available :—(1) Aerodrome floodlights, and (2) Landing direction lights.



The International Committee on Aircraft Navigation Lights at work in Berlin. The Chairman, M. L'Ingénieur en Chef Franck (France), is second on the right-hand side of the table.

Lighting on Aircraft

From the point of view of safety, the lighting on the aircraft is probably the most important subject. In this connection valuable work has already been performed by such bodies as the C.I.N.A. (Commission Internationale de Navigation Aerienne) and recommendations for the range of the red and green port and starboard lights and the white tail light have been made. For the definition of such ranges a standard of minimum visibility must necessarily be adopted, and in Berlin it was agreed by the International Committee that the intensity of navigation lights shall be fixed so that at the requisite range, their visibility shall not be less than that of a source having an intensity of 0·2 candles (a tentative figure) when seen at a distance of 1 km. In addition, the question of the light distribution from the lamp was considered, for it is evidently undesirable that undue concentration of the light into dead ahead or astern directions should be obtained at the expense of that in other directions. A form of light distribution in which the intensity vertically upwards and downwards must not be less than 50 per cent. of the maximum value was agreed upon.

Furthermore, endeavours were made to standardise the types of lamps, their caps and holders, so that the keeping of spares at aerodromes may become a simple matter. Navigation and instrument lamps were dealt with, and the small bayonet cap was decided upon for the first type. The question of standardised voltage proved somewhat difficult as both 12 V. and 24 V. systems are in use. It was recommended, however, that both systems be standardised for the present, and that further experience be gained on their relative merits.

Aerodrome and Airway Lighting

The aerodrome and airway lighting committee considered the various phases of the lighting problem in the order of their importance. Obstruction lights were considered first. These lights are used for marking obstructions on airways and in the vicinity of aerodromes, and it was unanimously agreed that they should be *red* in colour and *fixed* in character, and that the disposition of the lights should be such as to indicate the dimensions of the obstruction.

The discussion showed that pilots differ in their opinion as to the most useful system, but it appears that the younger generation has a preference for the landing floodlight. In the first system, the ground surface is illuminated by one or more projectors (which it was laid down must not dazzle the pilot), and in the second, the direction of landing is indicated by a line of small lights upon the ground. Both systems were accepted as being satisfactory.

Except for an illuminated wind indicator, the only other aerodrome light of major importance is the location beacon. This is in effect an aerial lighthouse used for indicating the position of an aerodrome, and it was agreed, as a desirable feature, that the beacon should enable the identity of the aerodrome to be established by its own or by auxiliary signals. In regard to the power of the light which is closely connected with the remainder of the airway lighting, it was agreed that the location beacon should be visible from the nearest airway beacon under average visibility conditions.

The airway beacon, as its name implies, is for the purpose of providing a visual check for aircraft. In general, beacons will be used on definite air routes, and it was recommended by two countries that all airway beacons (spaced 20-30 km. apart) should have the same character on any one airway or section thereof. It was not possible to agree unanimously on this point or on the question of intermediate beacons. The view of the British delegation on this latter question was that night flying pilots must be able to navigate and should not be encouraged to fly by beacons spaced at short intervals, which in bad weather may become invisible.

It has been possible in a short space to review only the more important recommendations of the Committee. These are now being referred back to the National Committees in each country for confirmation but, however little was definitely agreed in Berlin, this much has been achieved, that a stimulus has been given to the study of aviation lighting from an international standpoint. National Committees will now continue their investigations, and it is to be hoped that in September, 1931, when the International Commission on Illumination meets in Great Britain, the recommendations made in Berlin will be ratified and reports will indicate rapid developments.

DEVELOPMENTS AT THE "BRISTOL" ENGINE WORKS

ON Wednesday, May 21, the Bristol Aeroplane Company invited to Filton a number of Air Ministry officials, aircraft designers and manufacturers, technical press representatives, and others interested in the engine side of the firm's activities, either as suppliers of components or materials, and therefore as part producers, or as actual users of Bristol aero engines. The occasion marked the opening of a further addition to the works near the aerodrome, the workshop area having steadily increased since the first Bristol engines were produced there in two converted aeroplane hangars ten years ago, during which time the number of workpeople employed has increased from seventy to approximately seventeen hundred.

The guests, numbering between eighty and ninety, were first entertained to luncheon, following which the gathering was divided into eight parties which were conducted through the works, each party being headed by a thoroughly competent guide. With characteristic efficiency those responsible had left nothing undone which could make of the visit a success from all points of view. The ante-room in which the guests assembled before luncheon was hung with plans of the works showing the route taken during the course of production from the raw material to the tested engine, crated and ready for despatch, and also with many other instructive charts relating to output statistics, growth of personnel, etc. The opportunity provided by this interval of renewing old friendships and making fresh ones proved something of a counter-attraction, but in this it served an equally important purpose in the day's programme. Of the lunch it need only be said that it was calculated to put the guests in an appreciative humour. A brief but hearty speech of welcome was made by Mr. W. G. Verdon-Smith. A reference by Mr. Verdon-Smith to Mr. Fedden's efforts in bringing the Bristol engines to the position which they now hold aroused warm applause from the gathering, but Mr. Fedden whilst appearing duly appreciative, remained his usual (on such occasions) silent self.

In reply, Sir Sefton Brancker, remarking that whereas he usually had to be pushed on to his feet he was a volunteer on this occasion, recalled that his first acquaintance with the firm's products was about twenty years ago, when he was called upon to take charge of three Bristol "box-kites" in packing cases on the quayside at Calcutta in 1910 and on these (the "box kites," not the packing cases) he learnt to fly. He paid a tribute to pioneer work of the late Sir George White on the business side of the aircraft industry, and congratulated the firm on their long period of success as producers of some of the world's finest aircraft and engines, adding that he had had the utmost confidence in both during his long flying experience.

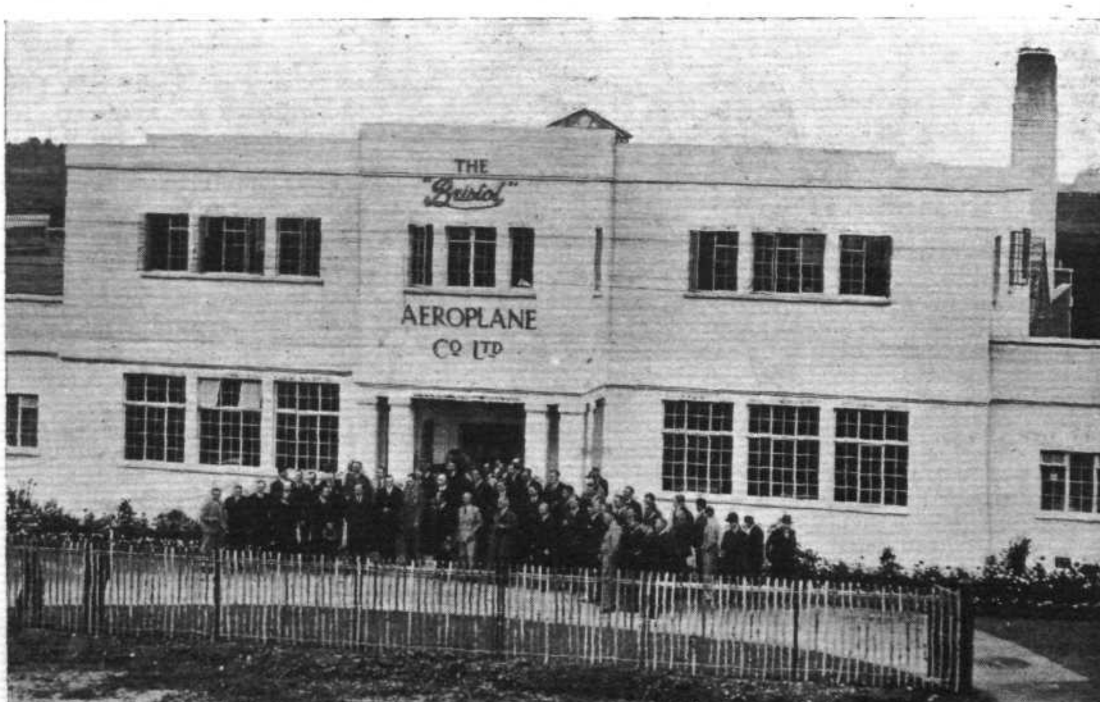
Of the visit it is not possible to give a full account of all that was to be seen, nor indeed was the time available sufficient to allow more than a few moments to be spent in each department, so that the material gathered in so short a time could not be complete enough to do justice to so interesting a matter; a full description of the works must be reserved for an article on that subject alone. We did, however, record a few of the items which most impressed us, and whilst refraining from giving statistics, there are a few figures which are of general interest.

One of the outstanding impressions is that, although the inspection is so rigid at all stages of manufacture, the organisation is such that the system of "flow" (as distinct from "mass") production progresses smoothly on from start to finish in a manner usually associated with less complicated and expensive productions. To carry out this system with such an intricate mechanism as an aero engine is indeed an achievement of efficient organisation. Although the firm's chief customer is the Government, keen rivalry and competition exists in the industry and prices have to be considered when orders are being placed, hence the most up-to-date production methods must be employed and everything must be done to avoid waste of time or material, the highest possible standard of workmanship being, of course, the first consideration. Bonuses are not paid on individual output, practically all the work people being on day-rate wages; only a few of the semi-skilled class are employed.

An interesting point is that the necessary concentration on the production of standard types of engine is not allowed to affect development work. Constant efforts are being made to "improve the breed" and, when as a result of intensive research modifications or improvements are to be made to standard types, these are incorporated, regardless of the temporary dislocation of production plans or the scrapping of plant, as occurred for instance last year when an entirely new form of cylinder head and valve rocker gear was introduced throughout the whole range of Jupiter engines.

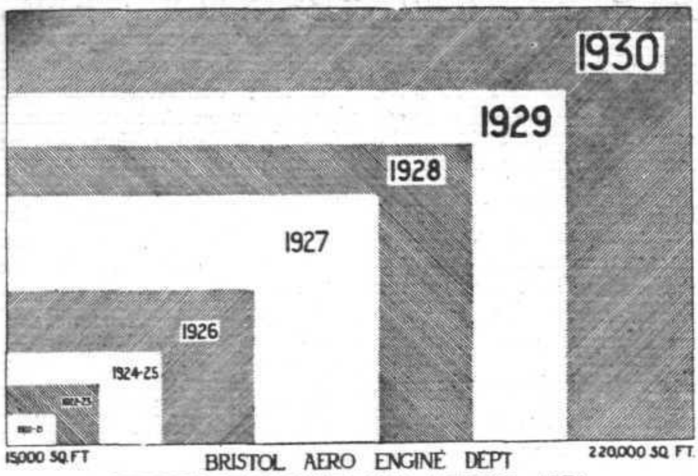
No less than seven single-cylinder testing units are employed for research work on cylinders, valve gear and cylinder heads, pistons, etc. From these, indicator diagrams are taken and temperature "explorations" are made by means of thermocouples. Slow-motion studies are made, with stroboscopic apparatus, of the behaviour of valve springs and to detect valve bounce and similar troubles. Components made of new materials or of differently treated materials are tested out in this way.

On the production side the thoroughness with which both the materials and components are tested, apart from the complete engine tests, is almost incredible. Nothing is left to chance; everything that is humanly possible is done to ensure that no part of the engine shall fail either through faulty material or workmanship. The following are a few examples illustrating this thoroughness. To ensure that no mistakes are made when drawing from stores such raw materials as steel or bronze bar, the distinctive colourings on each, according to specification, are painted not only on the end sections but along the whole length of the material.



Hosts and Guests at the entrance of the "Bristol" engine works.

A test piece is formed integral with every separate stamping and before the component is passed into finished stores the test room has to "O.K." the corresponding test piece. In addition to accurate gauging, certain finished parts are, when necessary, subjected to a profile test, as for instance gear teeth, screw threads, and sections through the hardened cups which contact with the ball ends of the valve push rods. The profiles of these are projected on a screen by an electric arc lantern, the greatly enlarged shadows so projected being checked by transparent templates of the exact form required by the design, correspondingly enlarged, the allowable manufacturing limits being marked thereon.



BRISTOL AERO ENGINE DEPT
COMPARATIVE DEPARTMENTAL BUILDING AREA

Chemical laboratories and mechanical test rooms ensure that all raw materials are of the required specification. There is also a "standards" department in which a specimen of every current component is kept, some of these being sectioned to show the required thickness of walls in castings, etc. The purpose of this "model room," as it is called, is to settle any dispute relating to the standard design of any component; should an argument arise the model room specimen is called in to decide it.

The engine tests are equally thorough. Before assembling to the engine the back cover, containing the auxiliary drives, is tested as a complete unit by driving it for a set time, whilst thin oil is circulated through the lubricating passages. Each complete engine is first motored for ten hours continuously at 600 r.p.m., using spindle oil as the lubricant, following which it is run a further two hours using castor oil. After the preliminary power tests it is given a two hours' endurance test at 90 per cent. full throttle, finishing with ten minutes at a full throttle. Following these tests each engine is stripped down and minutely examined for any signs of trouble. If any component is faulty a new assembly is substituted. To give an idea of the amount of test running that is carried out it may be remarked that the weekly fuel consumption for this purpose is 5,000 gallons.

Regarding production processes it is of interest to note that during the machining of the aluminium alloy cylinder head forging no less than 60 per cent. of the metal is removed. The employment of a forged duralumin crankcase instead of one of cast aluminium has reduced the number of rejects to about 1 per cent. Incidentally each case has seventy machining operations performed on it, these occupying a total of 14 hours, the jigs employed for most of this work enable it to be done by semi-skilled operatives. Castings have been eliminated as far as possible, but the firm runs its own foundry for the production of those that are used, important among these being pistons.

The oil consumption of the Jupiter has been considerably improved since honing was introduced for the finishing of the cylinder bores. Valve stems are finished by lapping-in. The induction spiral, valve throats, and other parts over or around which gas flow occurs are very highly polished, this refinement alone accounting for an extra 5 to 10 b.h.p.

An interesting process for producing the white-metal lined big-end bearing bush was demonstrated. White metal is placed in the bronze sleeve and is rotated at high speed, whilst the outer surface of the sleeve is heated above the melting point of the white-metal. During this process any impurities, which are lighter than the white-metal, are forced to the centre and are subsequently removed during boring.

It has been found that cadmium plating provides the best protection against corrosion and the cylinder barrels and heads of all Jupiter engines are now protected by this treatment.

Thz visit concluded shortly before 5 p.m., when, after light refreshments, those who were not travelling by air or road were provided with transport to Bristol station, and so ended a most instructive and enjoyable day. Among the guests were Sir A. V. Roe, Sir Sefton Brancker, Sir T. Nichol, Major Buchanan, Wing-Com. Hynes, Mr. Hobson, Mr. Firth, Mr. Berriman, Mr. Folland, Mr. Pierson, Major C. C. Turner, Col. Outram.

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CORRESPONDENCE

[The Editor does not hold himself responsible for opinions expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters intended for insertion in these columns.]

GLIDING

[**2311**] The letter (2310) from Mr. R. P. Thorpe in your last issue must have come as a shock to anyone with the least knowledge of gliding. He seems under the impression that gliders obtain their "power"—an incorrect and meaningless word in this case—by "swooping."

Actually, a glider or sailplane maintains height—termed "soaring"—by two distinct methods, viz., by "Static" soaring and "Dynamic" soaring. The former depends upon the presence of up-currents in the air. The conditions for gain of height are simple. The upward vertical component of the wind velocity must be greater than the least rate of fall of the glider. Up to the present this method of soaring is the only one by which continuous gain of height has been achieved. On the other hand, dynamic soaring depends upon the variations of wind velocity, either from time to time or from place to place. The theory is fairly well understood, but in practice the difficulty is that the pilot is required to move his controls in such a manner as to take advantage of the gusts. In a head wind of varying velocity the resulting "ideal" motion of the glider would approximate to a series of "swoops" of varying magnitude. I have heard that sailplane pilots have rolled their machines in order to take advantage of side gusts, but whether height is actually gained is uncertain. In "calm weather"—Mr. Thorpe's expression—manœuvres such as this would be of no use whatever, and a "swoop" would result in considerable loss of height.

As far as I am aware no successful instrument has yet been invented to show the pilot what he wishes to know, viz., whether the wind is "freshening" or "fading." I should like to correspond with Mr. Thorpe on the subject of his invention to make use of "pilot power." Frankly, I am sceptical, but I am willing to be convinced.

J. H. Payne.

South Kensington, S.W.7.
May 23, 1930.

A CORRECTION

[**2312**] My attention has been drawn to the report that you give in your issue of May 16, of a speech that I made upon the occasion of the twenty-first anniversary of the Air League. You say that I "supported Sir Alan Anderson with a diatribe against the Government policy." Either I must have expressed myself badly or your reporter must have incorrectly heard what I said, for from start to finish I did no such thing. I stated that all governments, my own included, were apt to say no to new inventions, but from criticism of the present Government I carefully refrained. I have always been anxious to keep air questions out of party politics, and nothing that I said in my speech at the Air League in any way transgressed my habitual attitude. I may add that the reports of my speech in other papers confirm my own memory of what I actually said.

Samuel Hoare.

London, S.W.3.
May 23, 1930.

THE ROYAL AIR FORCE

London Gazette, May 20, 1930

General Duties Branch

The follg. are granted temp. commns. as Flying Officers on attachment for duty with R.A.F. (May 11). *Lieutenants, R.N.*—Cecil Kenneth Ashwanden: James Arthur Laurence Drummond. *Sub-Lieutenants*, R.N.—Gerald Donald Anderson; Thomas Walter Townsend Blackwell; John de Filek Jago; George Bodley Kingdon; Wilfrid Henry Gerald Sanpt; William Gerald Williams. *Lieutenant, R.M.*—Nigel Robert Mackie Skene.

The follg. Pilot Officers on probation are confirmed in rank (April 28):—Derek Richard Charles Barrois de Sarigny; Charles Milsom Rees.

The follg. Pilot Officers are promoted to rank of Flying Officer:—Wilfrid Sydney Charles Adams (Feb. 24); Francis Joseph St. George Braithwaite, and Robert Harston (March 7); Harold Basset Collins, and Geoffrey Cuyler Holland (March 28); Denis Hensley Fulton Barnett (April 5); Frank Read (April 8); Charles Richard John Hawkins, Michael Thomas Mary Hyland, and Brian Arthur Oakley (April 12); Edward Gerard Granville, and Gershom Frederic Parkington O'Farrell (May 2).

Group Captain Sacheverell Arthur Hebden, O.B.E., is placed on retired list (May 17).

RESERVE OF AIR FORCE OFFICERS

General Duties Branch

The following are granted commns. in Class AA (ii) as Pilot Officers on probation: B. E. A. Pollard-Urquhart; March 19. N. J. Tindal; April 29. K. R. Boulton is granted a commn. in Class A as a Pilot Officer on probation; May 6. The following Pilot Officers on probation are confirmed in rank:—J. A. Ingles, S. H. R. Clarke; April 11. G. A. Hornblower; April 12. P. C. Hordern; April 15. C. G. Fraser, J. E. Walker; May 6. E. G. Curtice; May 9.

The follg. are granted commissions in Class A.A. (ii) as Pilot Officers on probation:—Allan Moncrieff Maclachlan (May 5); Richard Whitelegge O'Sullivan (May 5).

Pilot Officer James Paton is promoted to rank of Flying Officer (May 13). Flying Officer Charles Pakenham Vines is transferred from Class A to Class C (April 4). (Substituted for *Gazette* April 15.)

The follg. Flying Officers are transferred from Class B.B. to Class C.:—Alexander Robert John Savage (March 24). Gerard Bowes Kingston James (May 2).

Flying Officer William Newton Lancaster relinquishes his commn. on completion of service (April 30). Flight Lt. Charles Fenn relinquishes his commn. on completion of service, and is permitted to retain his rank (April 28). Flying Officer James Edward Doran-Webb relinquishes his commn. on account of ill-health and is permitted to retain his rank (May 21).

Medical Branch

Flying Officer Frank George Mogg is granted a commn. in Special Reserve on resignation of his commission in Class D.D. (March 4). Flight Lt. James Burgess Woodrow relinquishes his commission on completion of service (April 24).

AUXILIARY AIR FORCE

General Duties Branch

No. 602 (CITY OF GLASGOW) (BOMBER) SQUADRON.—The following to be Pilot Officer:—H. Land; Feb. 27.

No. 604 (COUNTY OF MIDDLESEX) (BOMBER) SQUADRON.—Lt.-Col. Alan Sidney Whitehorn Dore, D.S.O., to be Squadron Leader (Honorary Wing Commander) and to command the Squadron (March 19). The follg. to be Pilot Officer:—Abraham Eyre Chatterton (March 19).

No. 605 (COUNTY OF WARWICK) (BOMBER) SQUADRON.—Pilot Officer Sydney John Huins relinquishes his commn. on account of ill-health and is permitted to retain his rank (April 24). (Substituted for *Gazette* May 6.)

ROYAL AIR FORCE INTELLIGENCE

Appointments.—The following appointments in the R.A.F. are notified:—

Stores Branch

Flight Lieutenant F. C. Griffin, to No. 2 Stores (Ammunition) Depot, Altrincham; 4.5.30.

Flying Officers:—A. A. Quayle, to Aircraft Depot, India, 16.4.30. J. E. Welman, to Home Aircraft Depot, Henlow, 25.4.30.

Pilot Officers: B. A. Oakley, to No. 36 Sqdn., Donibristle; 13.5.30. D. J. Douthwaite, to R.A.F. Base, Gosport; 11.5.30. R. C. Keary, to R.A.F. Base, Gosport; 11.5.30. The undermentioned are all posted to the Home Aircraft Depot, Henlow, with effect from 28.4.30:—F. C. Read, W. A. Lee, L. Llewellyn, E. N. Lowe, J. W. C. Revill, G. C. Allen, B. S. Cartmel.

Medical Branch

Group Captain J. MacGregor, M.C., to R.A.F. Depot, Uxbridge, Supernumerary, on transfer to Home Estab., 20.4.30.

Squadron Leader W. E. Hodgins, to H.Q., Inland Area, Stanmore; 5.5.30.

Flight Lieutenant C. P. O'Toole, to R.A.F. Depot, Uxbridge; 23.3.30.

Flight-Lieutenant P. D. Barling, to No. 3 Flying Training Sch., Grantham, 23.6.30.

Flying Officer A. H. Barzilay, to Station H.Q., Hawkinge; 17.5.30.

Chaplains' Branch

The Revd. A. R. A. Watson, M.A., to Elec. and Wireless Sch., Cranwell, on appointment to a Short Service Commn.: 1.5.30.

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CROYDON WEEKLY NOTES

THE arrival of the Fokker F IX on Monday, May 19, aroused great interest and admiration—she really is an amazing piece of aero engineering, and an example of Dutch thoroughness and ingenuity.

Designed to carry 18 to 20 passengers and two crew, she will—as has been repeatedly proved—fly on any two of her three Jupiter engines with full load. Mr. Sillivus—the pilot—gave several demonstration flights, and it was found that the machine, with 12 passengers up, took only 6 secs. to "unstick," which is surely remarkable for such a large "'bus." The very spacious pilots' cockpit is entirely enclosed, and of course fitted with dual control.

The passenger cabin is equal in comfort to a first-class Pullman car. Measuring approximately 18 ft. by 7 ft. by 6 ft. 3 in., there is not only plenty of space to stretch one's legs, but almost room to promenade.

The undercarriage, which is of the usual Fokker two-halves type, with shock-absorber struts secured to the Power Eggs, has a track of 23 ft., and the wheel brakes may be operated independently of each other.

Speeds.—Maximum, 132; cruising, 115; minimum, 67 m.p.h. Range, 685 miles in 6½ hrs.

The Secretary of State for Air left Northolt for Antwerp on Tuesday, but had to "put in" at Ostend, owing to bad weather.

Neville Stack left Heston early Wednesday morning on Moth G-EBUF for Rome, in connection with his business tour for Smith & Sons., the world-renowned firm of instrument manufacturers. He expects to visit Rome, Madrid, Milan, Brussels and other capitals.

Friday was a day of unusual interest to Croydon, for in the morning O. P. Jones piloted the Argosy G-AACI to Glasgow, with the Prime Minister and Miss Ishbel MacDonald as passengers. Later in the day, H.R.H. the Prince of Wales left Hendon for Berck, with Flying Officer Fielden—the machine circled both Lympne and Alprech. *An example to be followed ! ! !*

Messrs. R. Runtz-Rees and Ogilvie-Forbes completed their night flying tests for "B" licences on Friday night. Jack Hylton and his band of 18 performers had a very "sticky" trip from Rotterdam on the Fokker F.9 on Sunday, May 25. Running into foul weather, they were over 2 hrs. flying in the mist in south-east England.

It is most gratifying to note that the Dutch pilot was so pleased with the help he obtained from D/F positions and bearings, that his first act on landing was to go straight to the control tower and thank the duty officer and wireless staff.

Quite a brisk trade was done in joy riding by Gordon P. Olley at Heston on Sunday, where, in spite of the miserable weather, he took up a total of 160 passengers, on short trips in the Argosy, during a meeting arranged by Auto-Auctions, Ltd., the Bluebird agents. By the way, "G.P.O." has again been distinguishing himself by beating liners by a "short head."

On this occasion, he flew a sub-editor of the Atlantic *Daily Mail* to Cherbourg to catch the outgoing R.M.S. *Berengaria*, which left Southampton at 9 a.m. on Saturday. Starting 3½ hrs. later from Croydon, he was easily able to fulfil his mission.

Lieut.-Col. G. L. P. Henderson, M.C., A.F.C., has opened a Bureau in the Central Hall of the Terminal Building, where he caters for every possible branch of aviation—aerial tours, special charter machines, construction, maintenance, repairs, insurance, and instruction. Those consulting him will have the benefit of his vast all-round experience, extending over 15 years, with 5,000 hrs. in the air, behind his advice. "Hendy" is modifying his Junkers 13 to be either a six-seater for short flights, or alternatively to take extra tanks for long-distance flights up to 12 hrs. with two passengers. Mr. "Jock" Anderson, pilot, parachutist, and ground engineer, is in charge of the technical maintenance side of the concern.

For week May 15 to 21—939 passengers—93 tons goods—were handled at Croydon.

"*There were sounds of revelry by night in the Kentish capital*"—when the Belgian freighter running into vile weather in the early hours of Friday, being unable to make Croydon decided to "stick around" Maidstone for over 2¼ hrs. The noise of the engines at low altitude brought hundreds of people from their beds—some thought a new war had started.

The police rang up the control tower several times, frantically requesting the duty officer to "Move the machine on," but the combined efforts of all concerned were without avail. The "Giant air liner," finding herself hemmed in by low cloud, flew merrily round and round until the first crack o'dawn, when taking advantage of a slight temporary improvement in the weather, she made a "sortie," and landed at Lympne.

"BILL."

DOPING WITHOUT A SHOP

USUALLY one associates with the process of applying dope to aircraft fabric a shop in which all sorts of precautions have to be taken. The temperature has to be kept fairly high, 65-70° F., and the relative humidity must not exceed 80 per cent. Ventilation must be the best possible, and so forth. The idea that it is possible to dope an aircraft in the open air does not occur to one, or if it does, one thinks of it as a sort of unattainable ideal which would be very convenient indeed, but which one has no hopes of realising. Consequently, it comes as something of a surprise to learn, from Cellon, Limited, that such a very convenient procedure is not an ideal but an accomplished fact. Thanks to Mr. Wallace Barr and his chemists, it is now possible to dope any aircraft part, or a complete machine, out in the open, where the fumes are carried away by the wind without the need for an expensive ventilation plant, etc. Moreover, the new doping scheme permits of working in quite low temperatures. In fact, the process has been successfully applied in the open air at temperatures considerably below freezing point ! Nor is a comparatively dry atmosphere required. The scheme works well in a relative humidity of up to 90 per cent.

The new Cellon scheme, known as "Doping Scheme C 2," enables an aircraft manufacturer to carry out his doping in the erecting shop instead of having to move the large components of a machine to a special doping shop, a very considerable convenience in many cases. It will, however, be the "Joy Ride" concern which will derive the greatest benefit from the new doping scheme. Touring about the country from place to place, with no permanent buildings in which to carry out the work, the joy-rider will be able to dope his machines in the open air on any particular field on which he finds himself by the time one of his machines requires re-doping. The small aircraft manufacturer, who starts work in a small shed (as several are doing just at the present time), will also benefit greatly from the latest results of Mr. Wallace Barr's ingenuity. Wherever he may happen to be building his machine, he can dope it in the same shop, provided he takes reasonable care that no other work is proceeding at the time which raises a lot of dust. The writer of these notes, some years ago, had the rather eccentric idea of building a canoe consisting of a very light framework braced by piano wire and covered with aeroplane fabric. To keep the fabric taut and waterproof, Cellon dope was employed. But the application of the dope (carried out in mid-winter) had to be done in a small room heated by an oil stove, and with the windows shut. For weeks afterwards the smell and taste of dope remained in one's breath, much to the disgust of the family. If Mr. Wallace Barr's C2 scheme had been available then, it would have been a godsend !

The "C2" doping scheme has been approved by the Air Ministry, and is especially intended for aluminium finishes, as complete doping can be carried out with two to three coats of pigmented dope of the required shade, followed by two to three coats of aluminium dope, thus eliminating the use of notro dope covering.

The Cellon materials used under "C2" scheme are as follows : 1, Pigmented acetate dope scheme C2 in all standard colours. 2, Aluminium acetate dope scheme C2. 3, Nitro identification colours and transparent dope covering scheme C2. 4, Thinning solution, type T.16. 5, Brush or spray cleaning solution, type T.9. 6, First coat transparent acetate dope scheme C2. Item 6 is only supplied when specially requested.

Further particulars concerning the new doping scheme can be obtained upon application to Cellon, Limited, Upper Ham Road, Kingston-on-Thames, and the technical department of the firm will be pleased to attend to any difficulties that may be encountered, or to demonstrate the spraying and brushing of dopes.

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MODELS

THE FLIGHT CUP HANDICAP COMPETITION

THIS competition attracted a large number of entries, both the Society of Model Aeronautical Engineers and the Model Aircraft Club being well represented.

Prize winners and record holders for the season 1929 were handicapped to the extent of 5 sec. for each first place, and record held, 3 sec. for each second place, and 2 sec. for each third place. The deductions being made from the best recorded durations. The model rising from the ground. The rapid advance in the design and performance of the fuselage model was soon in evidence.

Mr. A. M. Willis got his model away perfectly into a slight breeze. The model climbed steadily in large sweeping circles, and soon attained an altitude of about 120 ft. It continued to circle without losing height, until the power ran out after about 60 seconds, then the model seemed to hover for some time before it came gliding down slowly, finally to touch ground after the record-breaking flight of 97$\frac{1}{5}$ sec. duration, an improvement of 12$\frac{4}{5}$ sec. on the existing British record for this type of machine.

Messrs. Bullock, Pelly-Fry, Newell, Ives, Welding and Gibson each put up magnificent flights at a great height, their models making perfect three-point landings. However, Willis's effort could not be equalled, although Ives came near it with a flight of 84$\frac{1}{4}$ sec.

The flying was, without doubt, the best ever seen at Wimbledon Common.

It would be very nice if some of the other model aircraft clubs could send representatives to compete with the S.M.A.E and the T.M.A.C. We have in mind the Halton Aircraft Society, the Brittanic Aeroplane Club, the Model Aircraft Construction Club (Nottingham), Harrogate, etc.

Result.—1st, Mr. A. M. Willis, T.M.A.C., 97 — 3 = 94$\frac{1}{5}$ sec. ; 2nd, Mr. T. H. Ives, S.M.A.E., 84 — 0 = 84$\frac{1}{5}$ sec. ; 3rd, Mr. T. H. Newell, T.M.A.C., 75 — 15 = 60 sec.

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AERONAUTICAL PATENT SPECIFICATIONS

(*Abbreviations* : Cyl. = cylinder ; i.c. = internal combustion ; m. = motors. The numbers in brackets are those under which the Specification will be printed and abridged, etc.)

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